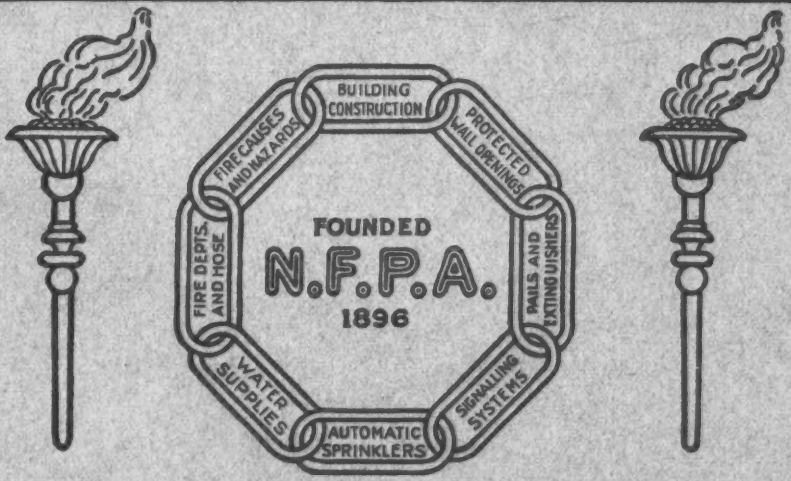
Vol. 29 JULY, 1935 No. 1
Published in two sections—Part 1

QUARTERLY
OF THE

NATIONAL FIRE PROTECTION ASSOCIATION



"To Promote the Science and Improve the Methods of Fire Protection and Prevention."

PUBLISHED QUARTERLY AT BOSTON, MASS., BY THE
NATIONAL FIRE PROTECTION ASSOCIATION

Printed in U. S. A.

The March of Time

• By constant research and vigorous development, the current models of automobiles have forged so far ahead that no one at equal cost would recommend the model of ten, five or one year back. In automobile selection the price is the last, not the first, consideration.

★ ★ ★

• Likewise — By restless, continuous research for better ways to design and build Automatic Fire Protection, we have translated our long experience into creating and now present as nearly perfect an Automatic Sprinkler Equipment as humanly possible—something more alert, responsive, flexible, refined and enduring, providing long life, minimum maintenance and lasting satisfaction to insurer and assured.

★ ★ ★

• *Our Aim Has Been High* — Our goal is attained in announcing *Super Fire Protection* — A triumph of Quality Equipment, representing the greatest advance in Fire Protection since the advent of the Automatic Sprinkler.

AHEAD WITH A WIDER LEAD THAN EVER!

• Globe Quality Automatic Sprinkler Systems, for all conditions and purposes, include:

Globe SAVEALL Automatic Sprinklers,
Globe Low Air Pressure (15 pounds) Dry Pipe Valves,
Globe Super-Sensitive Quick Opening Devices,
Globe Self-Supervised Control Valves,
Globe Factory Fabricated and Inspected Valves, Fittings, Hangers, etc.,
Cop-R-Loy Pipe with copper content, corrosive resisting,
Globe Airomatic Systems for Light Hazards.

★ ★ ★

Globe Quality Systems — The Peak of the Art

★ ★ ★

GLOBE AUTOMATIC SPRINKLER COMPANY
Executive Offices, 2035 Washington Avenue, Philadelphia, Pa.
Sales and Engineering Offices in all Principal Cities

Vol. 29 July, 1935 No. 1

QUARTERLY

OF THE

National Fire Protection Association

Annual Subscription $3.00.
Subscriptions are accepted only from members of the Association and are charged as a part of the annual dues. Membership is open to anyone interested.

Entered as second-class matter December 15, 1928, at the Post Office at Boston, Mass., under act of March 3, 1879.

60 BATTERYMARCH STREET, BOSTON, MASS.

National Fire Protection Association

INTERNATIONAL

Executive Office, 60 Batterymarch Street, Boston, Mass., U. S. A.

OFFICERS

HAROLD L. MINER, PRESIDENT
GEORGE W. ELLIOTT, FIRST VICE PRESIDENT
C. H. HAUPT, SECOND VICE PRESIDENT
ALBERT T. BELL, CHAIRMAN BOARD OF DIRECTORS

FRANKLIN H. WENTWORTH, MANAGING DIRECTOR
PERCY BUGBEE, ASSISTANT MANAGING DIRECTOR
ROBERT S. MOULTON, TECHNICAL SECRETARY

Organization Members

American Institute of Architects.
American Institute of Electrical Engineers.
American Association of Port Authorities.
American Boiler Manufacturers Association and Affiliated Industries.
American Gas Association.
American Marine Insurance Syndicates.
American Oil Burner Association, Inc.
American Petroleum Institute.
American Transit Association.
American Water Works Association.
Arizona Equitable Rating Office.
Arkansas Fire Prevention Bureau.
Asphalt Shingle and Roofing Institute.
Associated Factory Mutual Fire Insurance Co's., Inspection Department.
Associated Lumber Mutual Fire Insurance Companies.
Association of Canadian Fire Marshals.
Association of Edison Illuminating Companies.
Association of the Fire Alarm Industry.
Association of Fire Underwriters of Baltimore City.
Association of Mill and Elevator Mutual Insurance Companies.
Board of Fire Underwriters of the Pacific.
Board of Fire Underwriters of the Territory of Hawaii.
Board of Underwriters of New York, with which is incorporated the National Board of Marine Underwriters.
Boston Board of Fire Underwriters, Inc.
British Columbia Insurance Underwriters Association, Fire Branch.
Bureau of Explosives.
Canadian Automatic Sprinkler Association.
Canadian Fire Underwriters' Association.
Canadian Manufacturers' Association.
Cast Iron Pipe Research Association.
Cellulose Plastic Manufacturers' Association.
Central Station Fire Protection Association.
Central Traction and Lighting Bureau.
Chemical Fire Extinguisher Association, Inc.
Chicago Board of Underwriters.
Chlorine Institute, Inc.
Clay Products Association.
Compressed Gas Manufacturers' Association.
Cotton Insurance Association.
Diesel Engine Manufacturers' Association.
Eastern Underwriters Association.
Eastern Underwriters Inspection Bureau.
Edison Electric Institute.
Factory Insurance Association.
Factory Mutual Laboratories.
Federation of Mutual Fire Insurance Companies.
Fire Insurance Rating Bureau (Wis.)
Fire Underwriters Inspection Bureau (Minn., N. D., S. D.).
Idaho Surveying and Rating Bureau.
Illinois Fire Prevention Association.
Illinois Inspection Bureau.
Improved Risk Mutuals.
Indiana Inspection Bureau.
Institute of Makers of Explosives.
Insurance Association of Providence.
International Acetylene Association.
International Association of Fire Fighters.
International Association of Municipal Electricians.
International Brotherhood of Electrical Workers.
Iowa Insurance Service Bureau.
Kansas Inspection Bureau.
Kentucky Actuarial Bureau.
Lightning Rod Manufacturers' Association.
Louisiana Rating and Fire Prevention Bureau.
Manufacturing Chemists' Association of the United States.
Michigan Inspection Bureau.
Middle Department Rating Association.
Mississippi State Rating Bureau.
Missouri Inspection Bureau.
Motion Picture Producers and Distributors of America, Inc.
Motor Fire Apparatus Manufacturers' Association, Inc.
Mountain States Inspection Bureau.
Mutual Fire Inspection Bureau.
Mutual Fire Insurance Association.
National Association of Credit Men.
National Association of Engine and Boat Manufacturers, Inc.
National Association of Mutual Insurance Companies.
National Automatic Sprinkler Association.
National Board of Fire Underwriters.
National Clean Up and Paint Up Campaign Bureau.
National Electrical Contractors Association.
National Electrical Manufacturers' Association.
National Lumber Manufacturers' Association.
National Paint, Varnish and Lacquer Association.
Nebraska Inspection Bureau.
New Brunswick Board of Fire Underwriters.
New England Insurance Exchange.
Newfoundland Board of Fire Underwriters.
New Hampshire Board of Underwriters.
New Jersey Schedule Rating Office.
New York Board of Fire Underwriters.
New York Fire Insurance Rating Organization.
Nova Scotia Board of Fire Underwriters.
Ohio Inspection Bureau.
Oil Insurance Association.
Oklahoma Inspection Bureau.
Oregon Insurance Rating Bureau.
Pacific Factory Insurance Association.
Railroad Insurance Association.
Railway Fire Protection Association.
Rigid Steel Conduit Association.
Safe Manufacturers National Association.
Society of Grain Elevator Superintendents of North America.
Society of Motion Picture Engineers.
South-Eastern Underwriters' Association.
Tennessee Inspection Bureau.
Terminal Elevator Grain Merchants' Association.
Texas Inspection Bureau.
Texas State Fire Insurance Department.
Underwriters' Association of the District of Columbia.
Underwriters' Laboratories.
Underwriters Service Association.
Virginia Insurance Rating Bureau.
Washington Surveying and Rating Bureau.
Western Actuarial Bureau (Fire).
Western Canada Insurance Underwriters' Association.
Western Factory Insurance Association.
Western Sprinkled Risk Association.
Western Underwriters Association.
West Virginia Fire Underwriters' Association.
West Virginia Inspection Bureau.

Printed in U. S. A.

Table of Contents.

OREGON STATE CAPITOL FIRE ..... FRONTISPIECE

EDITORIALS 5

CIGARETTE SCORCHES 8

THE BOARD OF DIRECTORS 13

MEETINGS OF BOARD OF DIRECTORS 14

THE 1934 FIRE LOSS 19

LOSSES LOWER FOR FIRST PART OF 1935 23

CANADIAN FIRE LOSSES, 1934 23

STATISTICS OF FIRES IN CANADIAN AND FOREIGN CITIES 24

ATLANTA SCHOOL EXHIBIT 25

WASHINGTON MONUMENT LIGHTNING PROTECTION. *M. G. Lloyd* 26

THE USE OF WATER TO EXTINGUISH OIL FIRES. *A. L. Brown* 29

ALCOHOL- AND ACETONE-WATER MIXTURES 40

OREGON STATE CAPITOL FIRE. *Oregon Insurance Rating Bureau* 42

PAINT AND LACQUER SPRAYING FIRE RECORD 49

SPONTANEOUS IGNITION OF CHOPPED HAY. *Harry E. Roethe, Max A. Bradshaw and Ernest J. Hoffman* 57

BROOKLYN WATERFRONT WAREHOUSE FIRE. *New York Board of Fire Underwriters* 65

CONSOLIDATED SCHOOL FIRE, TIMNATH, COL. *Mountain States Inspection Bureau* 69

THREE INTERESTING GRAIN ELEVATOR FIRES. *Hylton R. Brown and David J. Price* 70

BACK BAY DWELLING FIRE, BOSTON 81

MEADOWMERE, NEW YORK, FIRE 82

FIRES IN WHICH THERE WAS LOSS OF LIFE. *Second Quarter, 1935* 84

Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.

The Oregon State Capitol was destroyed by fire on the night of April 25, 1935, with a loss of over $1,000,000. The building was of combustible construction without fire stops. There were no automatic sprinklers or fire alarms and no insurance was carried either on the building or the records which it contained. (See report, page 42.)

The Quarterly

Vol. 29 July, 1935 No. 1

Visualizing Our Objectives. A review of fire losses for 1933 is perhaps as good as that of any recent year for the purpose of objectifying the sectors inviting our attack. The figures for any of the last five years will probably break down into values equally suggestive of the burning areas. In 1933 the total fire loss of the United States is recorded as $270,000,000, with $78,000,000 of this loss occurring in the 461 cities over 20,000 population. The balance, $192,000,000, or 71 per cent of the total, occurred in the small towns and rural areas. This reveals the regional shifts going on for some time, resulting from the awakening of industry to the value of fire protection. We are now regularly reaching 12,000 of these smaller municipalities and towns through our Volunteer Firemen's Section, probably the most effective method of advancing our educational influence in such areas that could be devised.

An analysis of the situation in the larger cities shows that $29,000,000 of the $78,000,000 loss in these, or 38 per cent, occurs in twelve of them; and of this loss almost exactly half is in the cities of New York and Chicago alone. If we group with these twelve principal offenders 16 more cities having the heaviest losses, namely: Minneapolis, Kansas City, Atlanta, Louisville, Seattle, Omaha, St. Paul, Newark, Rochester, Cincinnati, Portland (Ore.), Memphis, Nashville, Dallas, Fort Worth and Houston, we add another $11,000,000 and have in these 28 over half of all the loss in the 461 U. S. cities over 20,000. In Canada the cities of Montreal, Toronto and Vancouver are responsible for 15 per cent of the total Canadian loss and undoubtedly for more than half of the Dominion losses in cities over 20,000. If we therefore maintain active field work in these 28 U. S. and 3 Canadian cities we shall be attacking the principal part of the fire loss in the cities over 20,000.

A review of our field activities of the past several years indicates that we have done our most effective work in cities by concentrating upon the following items:

1. The formation of fire prevention committees.
2. Stimulating adequate inspection work by fire departments.
3. The development of fire prevention codes and ordinances.
4. The promotion of fire-resistive roofing legislation.
5. The removal of dilapidated buildings.

6. Better investigation of fires.
7. Fire Department training.
8. Salvage work by fire departments.
9. Elimination of excessive water charges for sprinklers.

There is no denying the fact that the work remaining to be done along the above and other lines in cities is of great magnitude. But the accomplishments of our ten years of field service can now be so definitely recognized as to create no misgivings as to what may be done in the future.

* * * * * *

Omaha's Condemned Buildings. A method of ridding the city of hazardous dilapidated buildings has been adopted by the City of Omaha, which Chief Engineer Rodman M. Brown of the building department reports was designed to avoid difficulties encountered under the old ordinance in promoting wrecking operations. Section 2.3 (i) provides authority to tear down a condemned structure and sell the material to cover the cost of demolition. Any remaining balance of the proceeds of the sale is applied to back taxes. The way this ordinance works out in application is that generally the owner of a condemned building himself immediately bargains with somebody to remove the building. Wrecking operations usually begin within ten days, and sometimes in twenty-four hours after the Council has declared the building a nuisance. In the case of abandoned property, when the owner has died and heirs have left the city, if no claim is made within thirty days the building department sells the building to the highest bidder, and the money is applied to taxes which in most such cases have accumulated for several years.

* * * * * *

The New Orleans Wharf Sprinklers. Following a series of disastrous fires in New Orleans wharves which involved an average loss of over a million dollars a year for a considerable period, the New Orleans Dock Board decided upon a complete fire protection installation for their property, including water curtains and automatic sprinklers with central station supervision to protect the entire space under the wharves. This space, without subdivision and inaccessible for fire fighting, had in many previous cases been responsible for heavy losses when fires swept through the creosoted piling and timbers in the sub-structure.

When this installation was completed in 1931 it was described in the QUARTERLY (October 1931, page 138) with the following comment:

> Through this installation it is felt that the hazard of the New Orleans waterfront has been practically eliminated, and from being one of the most hazardous of ports from the fire hazard standpoint it is now one of the safest. New Orleans should reap a rich reward from her forethought in reduced fire losses and in continuity of operation of her shipping and the industries dependent upon it.

A fire on the Louisa Street wharf on May 24, 1935, reported by the Louisiana Rating and Fire Prevention Bureau (member N.F.P.A.), gives convincing evidence as to the value of this installation. The fire started, probably from a carelessly discarded cigarette or match, on the wooden wharf deck and burned down through a crack between the ends of two boards into the under deck space. An accumulation of fibers, slivers of wood and other combustible material in the cracks was readily ignited and kindled the larger wooden members, furnishing enough heat to vaporize the creosote, which produced an intense fire. Two sprinkler heads promptly opened and confined the fire to the point of origin, although there is evidence of intense heat extending from 5 to 8 feet away. The remaining glowing embers in the cracks, which could not be reached by sprinklers, were extinguished by hand hose before the fire department arrived.

In a similar fire the Mandeville Street Wharf was destroyed on March 11, 1930, and steamships at the wharf were damaged. If it had not been for the automatic sprinklers, the present fire in the opinion of the Louisiana Rating and Fire Prevention Bureau would have probably involved a loss of $500,000 to the wharf and cargo, as well as damaging three steamships moored at the wharf.

* * * * * *

Toy Balloons. Hydrogen-filled toy balloons sold by itinerant venders on the streets of most American cities present a hazard that seems to be little appreciated by the public, although several recent cases illustrate the danger. Hydrogen gas mixed with air is readily explosive and it seems reasonable to assume that more accidents would be reported were it not for the fact that relatively small quantities of gas are involved and that balloons are largely used outdoors, where the gas dissipates readily. When in a confined space, such as the interior of a closed automobile, an explosive mixture may be formed, ready to be ignited by a match or cigarette, as was the case in a serious accident reported from the Pacific Coast a few years ago. In Lynn, Mass., on May 30, 1935, two little girls were badly burned in an explosion of a gas-filled balloon which ignited from some unknown cause while the girls were watching a parade. It is significant that when this case was investigated by the Lynn Fire Department it was found that the vender of the balloons did not know the name of the gas with which the balloon was filled. Fire Marshal Lahey of Waterbury, Conn., reports a recent case where hydrogen-filled balloons were carried in an automobile in connection with a wedding celebration. During the ride the gas escaped, and when a member of the party lighted a cigarette the flash painfully burned all the occupants. The use of a combustible gas such as hydrogen, in balloons to be placed in the hands of small children, clearly presents a hazard which should be the subject of appropriate warnings if not of official regulations by municipal fire authorities.

Unusual Fire Death. A story comes to us from an authentic member source which we are not at liberty to disclose, of a death from fire under most unusual circumstances.

At the close of her tour of duty in a large summer estate one of the young women of the household staff retired to her room to relax and change her apparel for her period off duty. For refreshment after bathing she indulged in an alcohol rub. In preparing to dress her hair she attempted to make use of an open gas jet for heating her curling iron. Upon striking a match on the heel of her shoe to light the gas she was instantly enveloped in flame.

The evaporation of the alcohol on the woman's body caused the inflammable vapor to accumulate under her clothing. Upon lighting the match this was ignited. The intensity of the resulting flame caused severe burns extending practically over her entire body. As the result of this most unusual accident the young woman died after about four hours of the most intense suffering.

This type of accident might easily occur to anyone, especially to those who are accustomed to smoking during or immediately after an alcohol rub.

Cigarette Scorches.

The interest aroused by a brief paragraph in the April *News Letter* respecting a recent court decision denying liability of an insurance company for damage done to a piano and spinet desk by cigarette scorches leads us to present in the QUARTERLY such information as is available in our files concerning cases of this sort. We have notes on three such court decisions in the past year or two, the first two being confined to press clippings. The third is a more extensive record obtained through the courtesy of our member A. S. Whiteley of Wheeling, W. Va., from the lawyers trying the case, Messrs. Steptoe and Johnson of Charleston.

The press reports on the first two cases are as follows:

NEW YORK JOURNAL OF COMMERCE, DECEMBER 27, 1933.

"The filing of a suit at Baltimore about November 1, by Samuel Shear against the National Liberty Insurance Company in an effort to collect for damage done by a cigarette created considerable interest, as it was one of the first instances in which the company's decision not to recognize cigarette scorches as fires within the meaning of the fire policy has been questioned. The Peoples Court of Baltimore has since decided in favor of the defendant insurance company, holding that no fire occurred within the meaning of the policy."

BOSTON HERALD, JANUARY 6, 1934.

"A lighted cigarette that was tipped over from an ash tray on to a damask tablecloth is a 'friendly' fire and, although it damages the cloth, unless the cloth ignites and thus causes a 'hostile' fire, the owner of the cloth may not recover from the insurance company, Judge Ian MacDonnell held today.

"Judge MacDonnell gave his decision in an action brought by J. G. Osborne, who claimed $41.30 from the Federal Fire Insurance Company of Canada. Allowing $15 to the plaintiff, he concurred in the defense contention that there must be a 'hostile' or secondary fire in the article consumed or damaged before there can be a loss under the law."

The third case we are able to present more circumstantially because of Mr. Whiteley's assistance. A memorandum of the declaration of the plaintiff and the demurrer of the defendant reads as follows:

"Cigarette scorches on piano and spinet desk held not to be a fire within the meaning of the West Virginia standard form of fire policy.

"Decision by Court of Common Pleas of Cabell County, West Virginia: Action by Vass, insured, against the Girard Fire & Marine Insurance Company. Decision by Hon. H. C. Warth, Judge. Finding and judgment for the Company.

"The Court of Common Pleas of Cabell County which rendered this decision is a civil court of general jurisdiction in that county. From it appeals lie to the Circuit Court of the Sixth Circuit and to the Supreme Court of Appeals. The facts of the case are made available through the courtesy of Steptoe & Johnson, of Clarksburg and Charleston, West Virginia, attorneys for the Company, and who consulted the Judge rendering the opinion prior to submitting their report.

"The insured in this case filed her declaration averring, among other things, the following:

"' ***that among the property in said policy of insurance mentioned and described against the loss of or damage to which by fire said policy of insurance was intended to indemnify and did indemnify the plaintiff, were a piano and a spinet desk; that within the period of said policy and within one year prior to the institution of this present action various damages were inflicted upon said spinet desk and said piano while located and contained at said described place, by reason of the fact that certain persons temporarily deposited, at various times, at various places upon said piano and said spinet desk, cigars and cigarettes which they had been smoking, intending after such temporary depositing thereof later to resume smoking the same; that when thus placed upon said piano and said spinet desk these cigars and cigarettes were not flaming, but were emitting smoke and were throwing off heat, which heat scorched and marred said piano and said spinet desk at various places, without, however, causing flames or occasioning actual ignition of said piano and said spinet desk at any place; that by reason of said marring of said piano and said spinet desk the plaintiff has been damaged in the sum of $108.00.'

"The declaration further charged the failure and refusal of the company to pay the loss. To this declaration the defendant demurred, assigning the following grounds:

'1. The declaration does not state or describe a fire or fires within the meaning of the policy of insurance in said declaration mentioned and quoted.

'2. If the declaration states or describes a fire or fires, the same was or were not such fire or fires the occasioning of damage by which is within the purview of said policy of insurance.

'3. The loss and damage alleged in the declaration is not a direct loss and damage by fire within the meaning of the policy of insurance in said declaration mentioned and quoted.

'4. The said declaration is otherwise insufficient, for reasons appearing on its face.'

The court decided the demurrer in favor of the Company insurer and dismissed the plaintiff's case out of court. No detailed opinion was handed down. The court, however, said in a letter to counsel:

' ***I have reached a decision in the case, and am of the opinion that the damage complained of is not such a fire as is contemplated in the policy, and therefore my judgment is for the defendant (Company).'

"The amount of the claim is such as to be appealable to the Circuit Court of the Sixth Circuit and to the Supreme Court of Appeals. The insured has, however, signified an intention not to take such an appeal and the judgment of the court is therefore final."

A review of this case for a legal publication, made by Mr. Stanley C. Morris of Steptoe and Johnson, exhibits the background of court decisions which was presented by the defendants' attorneys in arguing their case. Mr. Morris says:

"The case of *Vass* vs. *Girard Fire & Marine Insurance Company* helps to clarify the discussion in fire insurance circles in recent years of the great and mounting cost of so-called cigarette 'fires.' As one local agent has written in a national insurance journal, 'The fact that cigarette claims are paid has been broadcast from bridge table to bridge table throughout the country.' It is said that the aggregate of these losses which have been paid runs perhaps into the hundreds of thousands of dollars per year. Fire underwriters have always taken the position that such losses do not constitute 'direct loss and damage by fire' within the meaning of that phrase as used in standard form policies. Payments of losses of this character have always been emphasized as 'accommodation payments.' Since the depression, however, payments have been refused in large measure and a few legal proceedings have resulted. So far as known, however, no case involving the question has gone to and been decided by any appellate court. The reason for this is, of course, the fact that most of the losses are so small as to be below the limit of appeal to the higher courts.

"The typical loss here referred to is caused by careless smokers discarding or temporarily laying aside 'burning' cigarettes upon valuable articles of furniture. Of course, the heat of such burning cigarettes occasions marring and damage of a readily observable physical extent. It does not follow, however, that such injurious consequences represent 'direct loss and damage by fire.' Fire and heat are not one; rather they are cause and effect. Damage by heat is not insured against as such by the terms of the standard fire policies, but only such losses as occur from actual misplaced or hostile fire. If a fire is intentionally set, say, for the purpose of heating a dwelling, and is kept within the confines of the furnace or stove wherein it is kindled, there can be no recovery for damages occasioned by the mere heat of such fire to the house or articles of furniture within it.

"The classic authority for this proposition is the case of *Austin* vs. *Drewe*, 6 Taunt (Eng.) 436.

"To the same effect are the following American cases: *Pappadakis* vs. *Netherlands Fire & Marine Ins. Co.*, 137 Wash. 430, 49 A. L. R. 402, 242 P. 641 (a burning lamp); *Briggs* vs. *North American Mercantile Ins. Co.*, 53 N. Y. 446 (a burning lamp); *United L. F. & M. Ins. Co.* vs. *Foote*, 22 Ohio St. 340, 10 Am. Rep. 735 (burning gas jet); *Fitzgerald* vs. *German A. Ins. Co.*, 30 Misc. Rep. 72, 62 N. Y. S. 824 (smoke from lighted lamp); *Hansen* vs. *Lemars M. Ins. Assn.*, 195 Iowa, 1,

186 N. W. 468 (smoke and soot from flame of oil stove). In commenting upon and approving the holding in *Austin* vs. *Drewe, supra,* the court in one of the cases last cited said:

"'***The fire did not escape from the stove. The damage was produced by the soot and smoke. It was held that there could be no recovery. In that case the fire itself was confined within the limit of the agency employed, to wit, the stove.'

Pappadakis vs. *Netherlands Fire & Life Ins. Co., supra.*

"Actual ignition is said by a leading recent authority to be the *sine qua non,* or essential of a recoverable loss under a standard form fire insurance policy:

5 Couch, Insurance, sec. 1197, p. 4318.

"Perhaps the leading American case from which helpful analogies can be drawn in considering the problem of the cigarette scorch is that of *Western Woolen Mill Co.* vs. *Northern Assurance Co.,* 139 F. 637. In that case the court said:

"'***"Fire" is defined in the Century Dictionary as "the visible heat or light evolved by the action of a high temperature on certain bodies, which are in consequence styled 'inflammable or combustible.'" In Webster's Dictionary "fire" is defined as "the evolution of light and heat in the combustion of bodies." No definition of fire can be found that does not include the idea of visible heat or light, and this is also the popular meaning given to the word.***'"

Western Woolen Mill Co. vs. *Northern Assur. Co., supra.*

"The damage which 'burning' cigarettes usually inflict upon furniture, while occasioned by heat, is not accompanied by visible heat or light evolved from the damaged furniture itself. It is therefore believed that under the authorities cited such damages do not represent 'direct loss and damage by fire.'

"Again, a live coal on the end of a cigarette is, or is the product of, a fire kindled intentionally for the purpose of consuming the tobacco. The heat from a burning cigarette deposited upon practically any article of household furniture will sere the material of such furniture almost to the ignition point. It will so char the fibers of a fabric that it will disintegrate and fall to dust at a touch, but it will seldom ignite. In the usual situation, however, the actual fire remains in the tobacco itself and is not communicated to the article which suffers the damage. It would seem therefore clearly to be and remain a friendly fire.

"Another writer, after stating the rule that there can be no recovery so long as the fire itself is confined within the limits of the agency employed, from the effects of smoke or heat, says:

"'In order to bring such consequences within the risk, there must be actual ignition outside of the agencies employed, not purposely caused by the assured, and these, as a consequence of such ignition, dehors the agencies.'

Wood, Insurance, sec. 103.

"There would therefore seem to be two logical grounds upon which liability can be denied in the case of the typical cigarette scorch damage, first, that the damage in question is not a 'direct loss and damage by fire' at all, and, second, that if it is such direct loss and damage by fire, it is by and through a 'friendly fire,' not communicated to the damaged article itself."

The number of claims upon the underwriters for scorching of rugs, pianos, tables and upholstered furniture where there is no real fire is astounding. Such losses have become especially numerous in recent years since smoking among women has been so widespread. The steady and continuous refurnishing of houses by this method suggests a new and polite form of arson

The N.F.P.A. Board of Directors, Boston, June 24, 1935.

exceedingly difficult to combat except by absolute refusal to pay policy losses where there is no actual fire. This the fire insurance companies seem making up their minds to do. They have at least reached the point of active discussion of such a policy. While such action, if adopted, may not positively reduce the number of fires from cigarettes, it will at least lift from the general public the burden of bearing these indefensible claims and from the underwriters the expense of adjusting them.

The Board of Directors.

The photograph on the opposite page, taken during the meeting of the Board of Directors held in Boston on June 24, 1935, includes all of the officers and Directors as of that date.* The officers, Directors and N.F.P.A. staff members in the photograph are as follows:

First row, left to right: H. T. Cartlidge, Assistant United States Manager, Royal Insurance Company, Ltd.; Franklin H. Wentworth, Managing Director, N.F.P.A.; H. L. Miner (President), Manager, Safety and Fire Protection Division, E. I. du Pont de Nemours & Company; Albert T. Bell (Chairman, Board of Directors), Chalfonte-Haddon Hall, Atlantic City; George W. Elliott (First Vice-President), General Secretary, Philadelphia Chamber of Commerce; Frederick T. Moses (Past President), President, Firemen's Mutual Insurance Company; Sumner Rhoades (Past President), Manager, Eastern Underwriters Association.

Second row, left to right: A. R. Small, President, Underwriters' Laboratories; Russell Grinnell, President, Grinnell Co., Inc.; W. E. Mallalieu, General Manager, National Board of Fire Underwriters; C. H. Haupt (Second Vice-President), Standard Oil Development Company; Robert S. Moulton, Technical Secretary; W. F. Hickey, Superintendent of Insurance, The New York, New Haven and Hartford Railroad Company; S. D. McComb, Manager, Marine Office of America; Arthur H. Kehoe, Vice-President, The United Electric Light and Power Company.

Third row, left to right: S. L. Nicholson, Acting Vice-President, Westinghouse Electric and Manufacturing Company; C. W. Mowry, Manager, Inspection Department, Associated Factory Mutual Insurance Companies; David J. Price, Principal Engineer in Charge, Chemical Engineering Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture; A. O. Dawson, President, Canadian Cottons, Ltd.; Percy Bugbee, Assistant Managing Director; John L. Wilds, Vice-President, Protection Mutual Fire Insurance Co.; R. E. Vernor, Manager, Fire Prevention Department, Western Actuarial Bureau; C. W. Pierce, Vice-President, The Continental Insurance Co.

*One additional Director, Mr. C. W. Johnson, was elected at this meeting and does not take his place on the Board until the next meeting.

Meetings of Board of Directors.

Atlanta, Georgia, May 13, 1935.

Present.

Albert T. Bell, Chairman
H. L. Miner, President
Geo. W. Elliott, Vice-President
F. T. Moses, Past President
Franklin H. Wentworth, Managing Director

Eugene Arms
W. F. Hickey
A. H. Kehoe
C. W. Mowry
D. J. Price
A. R. Small
R. E. Vernor

Business Transacted.

The report of the Chairman to the annual meeting was amended and approved.

A resolution prepared by Mr. Powell Evans was submitted by Chairman Elliott of the Committee on Hazards and Protection of Small Properties and laid upon the table in view of the acceptance by the Board of a paragraph on the same subject to be presented for adoption by the Association in the annual report of the Chairman.

The Committee on Hazards and Protection of Small Properties was continued and a vote of thanks extended to the Chairman for his satisfactory and efficient conduct of the committee's activities.

A committee of five, consisting of Mr. C. W. Mowry as Chairman and Messrs. Eugene Arms, Henry A. Fiske, D. J. Price and A. R. Small, was appointed to review the text of the Crosby-Fiske-Forster Handbook now being revised by the Executive Office for re-publication by the Association.

It was voted to recommend to the Chairman of the Committee on Laws and Ordinances that he withdraw from the program of the present annual meeting the report on a suggested form and requirements for an automatic sprinkler ordinance and that the Board increase the personnel of the committee from two to five members.

The report of the Treasurer was approved.

Approval was given to the draft of a resolution to be presented to the annual meeting on the need for the adoption of building codes to reduce municipal fire waste.

It was voted to approve for presentation to the Association all technical committee reports that had been printed and circulated in advance of the annual meeting.

It was voted to hold the summer meeting of the Board in Boston on Monday, June 24th.

Boston, June 24, 1935.

Present.

Albert T. Bell, Chairman
H. L. Miner, President
Geo. W. Elliott, Vice-President
Chas. H. Haupt, Vice-President
F. T. Moses, Past President
Sumner Rhoades, Past President
Franklin H. Wentworth, Managing Director

H. T. Cartlidge	C. W. Mowry
A. O. Dawson	S. L. Nicholson
Russell Grinnell	D. J. Price
W. F. Hickey	C. W. Pierce
A. H. Kehoe	A. R. Small
W. E. Mallalieu	R. E. Vernor
S. D. McComb	John L. Wilds

Business Transacted.

1. The following members were elected officers of the Corporation for the year 1935-1936:

President—Harold L. Miner.
First Vice-President—George W. Elliott.
Second Vice-President—C. H. Haupt.
Secretary-Treasurer and Managing Director—Franklin H. Wentworth.
Chairman, Board of Directors—Albert T. Bell.

2. Mr. C. W. Johnson of Philadelphia was elected a member of the Board for the current one-year term to replace Mr. Sidney J. Williams of Chicago, resigned.

3. It was voted to hold the 40th annual meeting at Atlantic City during the week of May 11, 1936.

4. The following Program Committee for the 40th annual meeting was appointed: The President, the Managing Director, and the Chairman of the Board of Directors.

5. Suggestions for the program of the annual meeting were discussed and referred to the Program Committee.

6. The Budget for 1935-1936 submitted by the Treasurer was approved.

7. Messrs. W. F. Hickey and A. H. Kehoe were selected to complete the Nominating Committee for 1936.

8. The Advisory Committee 1935-1936 was appointed to consist of Albert T. Bell, Chairman, H. L. Miner, Geo. W. Elliott, C. H. Haupt and C. W. Pierce.

9. The N.F.P.A. publication VOLUNTEER FIREMEN was discussed and it was recommended that the editors consider publishing a series of articles on firemen's training; also insertion of information respecting the availability of other N.F.P.A. literature at the headquarters of the volunteer company, member of the section.

10. It was voted that the Chairman appoint a technical Committee on Transportation of Hazardous Materials by Truck and that the personnel of this committee include two representatives of the oil industry.

11. A Committee on Policy was appointed, consisting of Albert T. Bell, Chairman, H. T. Cartlidge, Geo. W. Elliott, W. E. Mallalieu and C. W. Pierce, to which were referred the following matters for consideration and report to the Board:

(a) The relations of the N.F.P.A. to the American Standards Association and its cooperation therewith,

(b) The Building Code situation in the U. S. and what can be done by the N.F.P.A. to improve it,

(c) Reconciliation of technical differences between N.F.P.A. standards and the requirements in a proposed Fire Prevention Ordinance for cities promulgated by a member organization.

12. The Chairman was authorized to appoint a committee of five to investigate and report to the Board on the possibilities of organizing a Parent-Teacher Section of the N.F.P.A., and the following committee was appointed: H. L. Miner, Chairman, Albert T. Bell, Geo. W. Elliott, C. W. Johnson, and Franklin H. Wentworth.

13. The Committee on Laws and Ordinances was increased from two to five members by the addition of Messers. H. T. Cartlidge, Geo. W. Elliott, and F. T. Moses.

14. The draft of the amended National Electrical Code submitted by the Chairman of the Electrical Committee was approved. It was voted that a copy be filed with the National Board of Fire Underwriters and that the Chairman of the Electrical Committee be authorized to submit the revised code to the American Standards Association for registry.

Committee Business.

15. It was voted to request the Committee on Technical Committee Procedure to revise the roster of the Committee on Piers and Wharves.

16. CITY PLANNING AND ZONING: Approval was granted for the following revised wording of the paragraph on dangerous occupancies in the 1935 report:

"Of even greater importance from the viewpoint of fire protection as it is concerned with spaciousness, is the need for zoning authorities taking into consideration the potentially dangerous occupancies of industries, such as illuminating gas plants with gasometers, chemical plants, pyroxylin manufacturing and working plants, woodworkers, flour and cereal mills and grain elevators, dry cleaning plants, starch factories, floor covering factories, explosives manufacturing plants, paint and varnish factories, gasoline and oil storage and manufacturing plants, and the many other kinds of factories having marked inherent fire and explosion hazards, when uses to be normally prohibited are determined, and when applications are received to permit buildings to be occupied for such uses. The districts where oil, for example, can be stored above ground are commonly specified by ordinances which also regulate the minimum distances between such storage and other property. As respects one phase of the oil hazard, the reader is referred to the comment on 'Water-

fronts' on page 22 of the Brochure, and to page 30 concerning the menace of industry to life and property in residential districts. The fire prevention and protection engineers of local fire insurance rating and inspection bureaus will gladly assist municipal authorities in compiling or revising building and fire prevention codes. In this connection, attention is directed to a defect found in many zoning ordinances which while restricting prohibited dangerous occupancies to a specified list, fail to provide for the prohibition of other equally dangerous or otherwise objectionable uses. Such lists should be merely representative of the general intent and be supplemented by a general prohibition of all occupancies having noxious or offensive characteristics, or inherent fire or explosion hazards."

17. PIERS AND WHARVES: Approval was granted for the addition of the following paragraph to the 1935 report on the Construction and Protection of Piers and Wharves:

Flammable Liquids

1035. Gasoline and other flammable liquids shall not be stored or handled on piers and wharves, except as follows:

(a) On piers or wharves not used for general passenger and freight service, and complying with the Regulations for Marine Oil Terminals.

(b) Paint, solvents, and other flammable liquids in substantial sealed ICC containers handled as cargo.

(c) Fuel oil having a flashpoint of over 150° F. piped for bunker supply.

(d) Incidental use of flammable liquids as provided in paragraphs 1004, 1005, 1008, 1010, 1020 and 1023.

The committee also reported that it considered the recommendations of Mr. W. H. Scales of the National Lumber Manufacturers Association relative to Pars. 511 and 512 and recommends no change.

18. MANUFACTURING HAZARDS: The following amendments to the 1935 report of the committee were approved:

Division I. Spark Arresters.

Omit the words "Farm Buildings" from original sub-title under Domestic Spark Arresters reading: "For Use on Dwelling House Chimneys and Farm Buildings and Small Chimneys and Stacks."

Division III. Paint Spraying and Spray Booths.

Delete the last sentence from Paragraph 22 as it reads in the preprinted report, viz.:

"A sufficient clearance, or a ventilated collar shall be provided to protect combustible material or construction against ignition by radiated heat in event of a fire in the duct or stack. Such clearances may be waived if an automatic sprinkler is maintained in service inside the duct located at or near floors and roofs through which the duct passes."

Division IV. Finishing Processes.

The annual meeting approved the incorporation of a reference to systems in Par. 192, so that carbon tetrachloride and water spray systems would be recognized on an equal basis for the protection of dip tanks, in both cases subject to the approval of the inspection department having jurisdiction. The addition of the following note was approved:

"The use of carbon tetrachloride calls for special study and precautions."

Authority was requested to revise some of the illustrations appearing in the previous edition of the pamphlet on Finishing Processes to bring them up to date. Authority to approve the new drawings on behalf of the Directors was delegated to the Committee on Technical Committee Procedure.

Authority was given to change the title from "Finishing Processes" to "Dip Tanks" with sub-title "Hardening and Tempering Tanks, and Flow Coat Work," as the material on ovens and on paint spraying formerly included in this pamphlet is now separately published and the title "Finishing Processes" would not be properly descriptive of the 1935 edition.

19. The COMMITTEE ON TECHNICAL COMMITTEE PROCEDURE reported its action on technical committee and A.S.A. matters and recommended changes in committee personnel (Minute 20) with comments on certain requests for representation which were not recommended.

The committee reported approval of a change in a minor technical detail on sulphur content in the standard for cotton rubber lined fire hose for which the N.F.P.A. is joint sponsor as a member of the A.S.A. Fire Protection Group.

The committee reported assent on behalf of the N.F.P.A. to a standard for power operated radio receiving appliances submitted by Underwriters' Laboratories to the A.S.A. under the proprietary sponsorship plan.

The committee requested authority to make routine replacements in committees and certain changes in the committees on Blower and Exhaust Systems, Field Practice, and Manufacturing Hazards, prior to the publication of the 1935 Year Book, subject to confirmation by the Board of Directors at its next meeting.

The committee recommended retaining both of the present N.F.P.A. representatives to the A.S.A. Sectional Committee on Testing of Petroleum Products and Lubricants which is being reorganized and to which the Fire Protection Group has been asked to reduce its representation to one.

The committee reported further activity on scope statements to be complated for the 1935 Year Book with the exception of that for the Electrical Committee.

The above report was accepted with approval of the action taken and authorization to proceed on committee matters as requested.

20. COMMITTEE AND A.S.A. APPOINTMENTS: Various committee appointments were approved. (The revised personnel will be shown in the 1935 Year Book.)

The 1934 Fire Loss.

Fire losses for the United States for the year 1934 as estimated by the National Board of Fire Underwriters were $262,848,122, the smallest since 1916, and a decrease of $8,605,067, or 3.2 per cent from 1933.

The following tables give the annual fire loss in the United States for sixty years and a comparison of losses on a per capita basis for the past ten years. In addition, there have been included tables showing the per capita losses of all cities of 100,000 population or over for a five-year period, and a tabulation of all cities of 20,000 population or over where the per capita fire loss exceeded five dollars during the past year. Cities in this class totaled twenty, doubling the number in 1933. This number is still below the average number for recent years. The number of cities in this group being sixty-four in 1930, forty-seven in 1931, thirty-four in 1932, or an average of thirty-five cities for the past five years. In eleven of the twenty instances the high per capita loss figure was attributable to one large fire causing a loss of $250,000 or over. The location of these fires was shown by the Annual Conflagration map appearing on page 212 of the January, 1935, QUARTERLY. The cases of Burbank, Calif., with a $500,000 motion picture studio fire, and Newport News, Va., with a grain elevator loss of $770,756 are typical.

Annual Fire Losses in the United States for Sixty Years.

Year	Property Loss	Year	Property Loss	Year	Property Loss
1875.....	$78,102,285	1895.....	$142,110,233	1915.....	$172,033,200
1876.....	64,630,600	1896.....	118,737,420	1916.....	258,377,952
1877.....	68,265,800	1897.....	116,354,575	1917.....	289,535,050
1878.....	64,315,900	1898.....	130,593,905	1918.....	353,878,876
1879.....	77,703,700	1899.....	153,597,830	1919.....	320,540,399
1880.....	74,643,400	1900.....	160,929,805	1920.....	447,886,677
1881.....	81,280,900	1901.....	165,817,810	1921.....	495,406,012
1882.....	84,505,024	1902.....	161,078,040	1922.....	506,541,001
1883.....	100,149,228	1903.....	145,302,155	1923.....	535,372,782
1884.....	110,008,611	1904.....	229,198,050	1924.....	549,062,124
1885.....	102,818,796	1905.....	165,221,650	1925.....	559,418,184
1886.....	104,924,750	1906.....	518,611,800	1926.....	561,980,751
1887.....	120,283,055	1907.....	215,084,709	1927.....	472,933,969
1888.....	110,885,665	1908.....	217,885,850	1928.....	464,607,102
1889.....	123,046,833	1909.....	188,705,150	1929.....	459,445,778
1890.....	108,993,792	1910.....	214,003,300	1930.....	501,980,624
1891.....	143,764,967	1911.....	217,004,575	1931.....	451,643,866
1892.....	151,516,098	1912.....	206,438,900	1932.....	400,859,554
1893.....	167,544,370	1913.....	203,763,550	1933.....	271,453,189
1894.....	140,006,484	1914.....	221,439,350	1934.....	262,848,122

NOTE:—Previous to 1916 figures obtained from the records of the New York *Journal of Commerce*, deducting the Canadian losses. Subsequent years are based on returns to Actuarial Bureau of the National Board of Fire Underwriters, adding 25% for unreported and uninsured losses. The figure for 1934 is based on estimates made by the Actuarial Bureau.

Comparative U. S. Fire Losses.

	Whole Country			Cities of 20,000 Population and Over		
	Population	Total Loss	Per Capita	Population	Total Loss	Per Capita
1925.....	115,378,094	559,418,184*	4.85	45,297,469	160,011,951†	3.53
1926.....	117,136,000	561,980,751	4.80	53,243,778	178,178,874	3.35
1927.....	119,320,000	472,933,969	3.96	51,291,549	144,618,641	2.82
1928.....	120,013,000	464,607,102	3.87	51,836,000	140,038,116	2.70
1929.....	120,700,000	459,445,778	3.81	53,411,000	145,059,043	2.72
1930.....	122,775,046	501,980,624	4.09	50,206,000	150,981,223	3.01
1931.....	124,070,000	451,643,866	3.64	51,084,000	125,933,681	2.47
1932.....	124,822,000	400,859,554	3.21	51,295,000	113,947,789	2.22
1933.....	125,693,000	271,453,189	2.16	51,553,000	77,686,291	1.51
1934.....	126,425,000	262,848,122	2.08	51,179,000	82,770,881	1.59

*Estimated from Records of the Actuarial Bureau. †Figures reported by fire departments.

Losses in Cities of 20,000 Population or Over.

Losses in cities of 20,000 population and over as reported by the fire department officials show an increase of 6.3% from 1933. Since 1932 the fire loss record of the cities has not improved at the same rate as that of the country as a whole, which with the present increase in city losses is bringing the per capita loss figure for the country and that of the cities closer together. However, the high level of destruction still remains in the smaller communities and rural districts rather than in the large urban centers. The per capita loss for the country as a whole is $2.08 as compared with but $1.59 average for the 468 cities of 20,000 population or over.

Per Capita Fire Losses of Cities Over 500,000 Population.

	Population	1930	1931	1932	1933	1934	Five-Year Average
New York, N. Y.*.....	7,473,000	$3.47	$3.24	$3.38	$1.88	$1.75	$2.74
Chicago, Ill.	3,475,000	4.48	2.73	3.42	1.64	3.18	3.09
Philadelphia, Pa.	1,950,000	2.72	2.12	2.09	1.19	1.10	1.84
Detroit, Mich.	1,395,000	2.74	2.30	1.82	1.37	1.47	1.94
Los Angeles, Cal.....	1,300,000	1.27	1.82	1.14	.85	.65	1.15
Cleveland, O.	900,000	4.26	2.61	2.26	.94	1.84	2.38
St. Louis, Mo.....	900,000	2.58	1.77	1.67	1.70	1.68	1.88
Baltimore, Md.	837,000	2.84	1.53	3.29	1.68	.84	2.04
Boston, Mass.	795,000	6.54	5.14	5.27	2.93	2.98	4.57
Pittsburgh, Pa.	700,000	1.69	1.61	1.25	.64	.96	1.23
San Francisco, Cal.†.....	695,000	...	...	...	...	...	...
Milwaukee, Wis.	613,000	2.83	1.60	1.23	2.23	1.05	1.79
Buffalo, N. Y.....	573,000	2.00	2.20**	2.17	1.69	2.25	2.06

†Does not report its losses.

*These figures are based on losses paid in New York City by the subscribers to the Actuarial Bureau of the National Board of Fire Underwriters. The fire department estimates for these years were considerably lower.

**Incomplete. Does not include Buffalo Armory fire, involving loss of at least $2,500,000.

Cities from 400,000 to 500,000 Population.

	Population	1930	1931	1932	1933	1934	Five-Year Average
Washington, D. C.	495,000	$2.59	$ .75	$ .72	$ .80	$ .48	$1.09
Minneapolis, Minn.	490,000	3.25	3.06	2.33	2.35	1.75	2.55
New Orleans, La.	472,000	1.57†	1.42	1.47	.92	.65	1.21
Cincinnati, O.	468,000	1.74	1.89	1.37	1.30	1.19	1.50
Newark, N. J.	444,000	3.62	2.82	2.14	1.38	1.19	2.23
Kansas City, Mo.	431,000	3.69	2.71	4.05	1.72	1.96	2.83

Cities from 300,000 to 400,000 Population.

Seattle, Wash.	395,000	$2.14	$2.94	$2.38	$1.16	$1.58	$2.04
Indianapolis, Ind.	367,000	2.66	1.44	1.19	1.02	1.23	1.51
Rochester, N. Y.	328,000	1.67	1.65	1.26	1.63	1.16	1.47
Jersey City, N. J.	325,000	2.26	1.14	.53	.42	.28	.93
Houston, Tex.	320,000	3.05	3.43	4.86	2.39	1.34	3.01
Portland, Ore.	318,000	2.55	3.04	2.21	2.14	1.98	2.38
Toledo, O.	309,000	2.98	3.70	2.06	1.10	1.17	2.20
Louisville, Ky.	308,000	4.33	3.19	1.53	1.93	1.57	2.51
Columbus, Ohio	300,000	1.22	.40	.65	.39	.71	.67
Denver, Col.	300,000	1.84	1.25	2.18	1.00	1.11	1.48

Cities from 200,000 to 300,000 Population.

Dallas, Tex.	293,000	$6.66	$5.59	$4.47	$3.18	$2.86	$4.55
Atlanta, Ga.	292,000	6.73	2.48	1.38	2.17	.67	2.69
Oakland, Cal.	286,000	2.65	2.83	1.44	1.39	1.30	1.92
St. Paul, Minn.	286,000	3.68	2.70	2.67	1.93	2.22	2.64
Birmingham, Ala.	264,000	2.11	3.09	1.93	1.28	7.95	3.27
Memphis, Tenn.	264,000	5.54	4.03	3.19	2.35	2.23	3.47
Providence, R. I.	259,000	2.86	3.63	1.39	.66	.77	1.86
Akron, O.	250,000	1.64	1.18	.84	.91	.65	1.04
San Antonio, Tex.	243,000	.94	1.05	1.44	.64	.41	.90
Omaha, Neb.	225,000	2.07	2.56	2.87	3.77	1.20	2.49
Syracuse, N. Y.	210,000	2.39	2.50	2.49	1.48	2.31	2.23
Dayton, O.	206,000	1.07	1.07	1.73	2.33	1.02	1.44
Worcester, Mass.	200,000	3.69	5.14	4.62	1.66	2.35	3.49

Cities from 150,000 to 200,000 Population.

Richmond, Va.	190,000	$ .83	$1.24	$ .65	$1.28	$ .46	$ .89
Oklahoma City, Okla.	183,000	3.12	1.15	.77	.38	.46	1.17
Youngstown, O.	170,000	3.05	1.64	.89	.47	1.23	1.45
Fort Worth, Tex.	170,000	5.58	6.55	3.96	2.92	2.28	4.26
Grand Rapids, Mich.	169,000	1.00	2.05	.67	.88	.48	1.02
Hartford, Conn.	164,000	3.12	1.87	1.99	.68	1.19	1.77
New Haven, Conn.	163,000	2.78	2.47	1.86	1.75	2.72	2.32
San Diego, Calif.	160,000	1.13	.57	.96	.70	.97	.87
Nashville, Tenn.	160,000	5.89	4.55	4.98	3.96	2.50	4.38
Flint, Mich.	156,000	2.25	.89	1.17	.96	1.28	1.31
Springfield, Mass.	150,000	2.15	3.20	4.14	1.57	2.15	2.64
Long Beach, Cal.	150,000	1.19	1.11	.43	.91	.38	.80

†The New Orleans per capita loss figure for 1930 obviously does not include the two wharf fires which occurred during March, 1930, with a total loss of approximately $4,000,000.

Cities from 125,000 to 150,000 Population.

	Population	1930	1931	1932	1933	1934	Five-Year Average
Bridgeport, Conn.	147,000	$ .74	$1.05	$1.98	$ .47	$ .88	$1.02
Des Moines, Iowa	143,000	5.03	1.50	1.42	1.41	1.49	2.17
Scranton, Pa.	143,000	2.71	2.10	2.84	1.76	2.84	2.45
Tulsa, Okla.	142,000	1.24	.87	.84	.84	.70	.90
Salt Lake City, Utah	140,000	2.90	3.07	1.52	1.73	.79	2.00
Yonkers, N. Y.	140,000	1.78	2.18	1.68	1.72	.61	1.59
Paterson, N. J.	138,000	8.99	3.50	2.41	1.83	2.00	3.75
Jacksonville, Fla.	138,000	3.23	8.64	4.21	2.73	2.00	4.16
Norfolk, Va.	130,000	3.11	9.09	3.12	2.42	3.12	4.17
Albany, N. Y.	127,000	2.56	4.24	1.73	1.69	1.35	2.31
Kansas City, Kans.	125,000	1.00	.86	2.69	.68	3.79	1.80

Cities from 100,000 to 125,000 Population.

Trenton, N. J.	123,000	$1.77	$2.70	$1.12	$2.04	$ .51	$1.63
Chattanooga, Tenn.	120,000	8.57	2.91	1.27	2.63	1.23	3.32
Elizabeth, N. J.	120,000	2.79	1.83	2.22	1.19	.56	1.72
Camden, N. J.	119,000	...	...	1.86	1.68	1.49	1.68
Erie, Pa.	117,000	1.08	1.78	1.86	.68	.51	1.18
Tampa, Fla.	117,000	1.51	2.32	1.94	.87	.71	1.47
Spokane, Wash.	116,000	2.32	2.55	1.74	2.21	.86	1.94
Fort Wayne, Ind.	116,000	2.16	1.56	1.02	.69	.74	1.23
Fall River, Mass.	116,000	1.60	1.69	2.36	2.16	2.62	2.09
Peoria, Ill.	115,000	2.50	2.34	3.29	.89	1.27	2.06
Cambridge, Mass.	114,000	7.57	4.14	3.57	1.29	1.28	3.57
Evansville, Ind.	114,000	5.68	1.76	1.97	1.13	1.19	2.35
Reading, Pa.	114,000	2.58	3.67	.76	1.10	.35	1.69
Wichita, Kans.	111,000	.68	.76	1.13	.95	.65	.83
New Bedford, Mass.	110,000	1.77	1.50	.87	.83	.61	1.12
Miami, Fla.	110,000	.94	1.20	1.28	.75	1.14	1.06
Wilmington, Del.	110,000	.89	2.35	2.01	2.37	1.12	1.75
Knoxville, Tenn.	109,000	3.57	1.29	1.18	.66	.98	1.54
Tacoma, Wash.	107,000	6.09	2.93	2.51	1.85	4.70	3.62
Somerville, Mass.	105,000	3.86	2.81	2.54	2.40	3.29	2.98
Utica, N. Y.	105,000	4.86	6.59	4.09	1.84	1.69	3.81
Gary, Ind.	105,000	3.66	2.64	3.54	.61	.34	2.16
Canton, O.	104,000	2.59	1.12	.97	.57	.65	1.18
South Bend, Ind.	104,000	1.81	.91	1.20	.75	.77	1.09
Lynn, Mass.	103,000	3.89	4.52	4.71	2.85	1.94	3.56
El Paso, Tex.	103,000	1.18	3.76	1.02	.50	1.23	1.54
Lowell, Mass.	102,000	2.80	2.41	2.46	2.08	1.49	2.25
Duluth, Minn.	101,000	4.61	3.66	3.48	2.01	1.52	3.06
Waterbury, Conn.	100,000	1.78	2.15	2.33	1.98	1.51	1.95
Allentown, Pa.	100,000	1.05	.33	5.33	1.52	.23	1.69

Cities in Which Loss Exceeded $5.00 Per Capita in 1934.

Burbank, Cal.	$26.50	Vallejo, Calif.	$9.66
Newport News, Va.	23.23	*Springfield, Ill.	8.68
*Anderson, Ind.	15.18	Union City, N. J.	8.61
Oswego, N. Y.	10.03	Birmingham, Ala.	7.95

Shawnee, Okla.	$7.84	Pawtucket, R. I.	$5.62
*Watertown, N. Y.	7.53	*Lynchburg, Va.	5.59
Cohoes, N. Y.	6.15	Saginaw, Mich.	5.27
Kankakee, Ill.	6.13	Westfield, Mass.	5.08
*Holyoke, Mass.	6.08	West Allis, Wis.	5.06
Tyler, Tex.	5.64	*Wilmington, N. C.	5.04

Note:—Asterisks indicate the cities which have been in this class in two of the past five years.

Losses Lower for First Part of 1935.

The fire losses for the United States for the first five months of 1935 were $117,960,966, which is $20,097,862, or 14.5%, less than for the same period last year, according to the estimates prepared by the National Board of Fire Underwriters.

	1931	1932	1933	1934	1935
January	$44,090,449	$39,224,783	$35,547,565	$28,002,583	$23,430,504
February	41,776,051	39,824,622	36,661,481	31,443,484	25,081,625
March	44,074,362	49,189,124	35,321,248	31,312,359	24,942,703
April	41,423,764	43,822,233	27,825,970	22,028,943	23,267,929
May	37,835,273	39,270,524	24,338,714	25,271,459	21,238,205
Total—5 months	$209,199,869	$211,331,286	$159,694,978	$138,058,828	$117,960,966

Canadian Fire Losses, 1934

Canadian fire losses for the year 1934 amounted to $25,437,840, sustained in 43,622 fires, according to statistics furnished by J. Grove Smith, Dominion Fire Commissioner. These figures show another substantial reduction in losses and continuation of the downward trend started in 1932. The reduction in the amount of property loss in 1934 amounted to $7,238,474, or 22.1% less than the 1933 loss, which was in turn 22.6% less than the loss for the previous year. The number of fires reported also showed a reduction of 2544.

Losses by Provinces.

	Population	Loss, 1933	Per Capita Loss, 1933	Loss, 1934	Per Capita Loss, 1934
Alberta	731,605	$1,435,612	$1.96	$1,177,370	$1.60
British Columbia	694,263	1,852,253	2.66	1,988,501	2.86
Manitoba	700,139	1,146,000	1.64	1,195,160	1.70
New Brunswick	408,219	2,188,200	5.37	823,523	2.02
Nova Scotia	512,846	1,779,614	3.47	1,219,215	2.38
Ontario	3,431,683	11,250,182	3.27	10,040,144	2.92
Prince Edward Island	88,038	272,696	3.09	191,103	2.17
Quebec	2,874,255	10,862,250	3.76	7,567,975	2.65
Saskatchewan	921,785	1,869,903	1.71	1,233,335	1.33
Not reported	.....	19,604	...	1,514	...
Total	10,374,196	$32,676,314	$3.15	$25,437,840	$2.44

A Decade of Fire Losses in Canada.

Year	Property Loss	Per Capita	Year	Property Loss	Per Capita
1925	$40,729,724	$4.35	1930	$46,109,875	$4.70
1926	38,295,096	4.15	1931	47,117,334	4.54
1927	32,254,084	3.29	1932	42,193,815	4.06
1928	36,402,018	3.79	1933	32,676,314	3.15
1929	47,499,746	4.85	1934	25,437,840	2.44

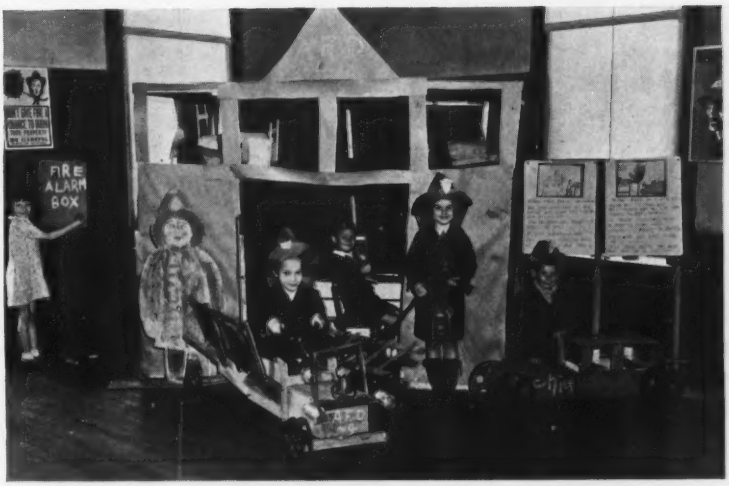
Population Group Loss Classification.

Group	Total Loss, 1934	Per Capita
Cities over 10,000 population	$7,789,341	$1.79
Towns 5,000 to 10,000 population	1,215,307	2.86
Towns 1,000 to 5,000 population	1,439,816	2.90
Villages under 1,000 population	3,076,584	5.96
Rural districts	11,916,792	2.48
Total	$25,437,840	$2.44

Statistics of Fires in Canadian and Foreign Cities, 1934.

Reported by National Board of Fire Underwriters. Losses are figured at par exchange.

City	Population	Per Capita Loss
Canada		
Montreal	1,176,000	$1.84
Toronto	624,000	1.58
Vancouver	245,000	1.23
Winnipeg	223,000	1.17
Great Britain		
Birkenhead	151,000	.24
Birmingham	1,028,000	.77
Bolton	177,000	.46
Bradford	298,000	1.48
Brighton	149,000	.27
Cardiff, Wales	222,000	.29
Edinburgh, Scotland	439,000	1.53
Glasgow, Scotland	1,111,000	.69
Kingston-on-Hull	318,000	2.19
Leeds	485,000	3.03
Liverpool	858,000	.85
London	4,397,000	.51
Manchester	769,000	.81
Southampton	180,000	1.80
Stoke-on-Trent	276,000	.64
Europe		
Vienna, Austria	1,854,000	.08
Bordeaux, France	263,000	.52
Lyon, France	590,000	.65
Hamburg, Germany	1,114,000	.06
Stuttgard, Germany	422,000	.25
Turin, Italy	623,000	.93
Venice, Italy	271,000	.42
Oslo, Norway	263,000	3.26
Lisbon, Portugal	600,000	.20
Stockholm, Sweden	526,000	3.44
China		
Shanghai	3,550,000	.09
New Zealand		
Wellington	115,000	1.09



Atlanta School Exhibit.

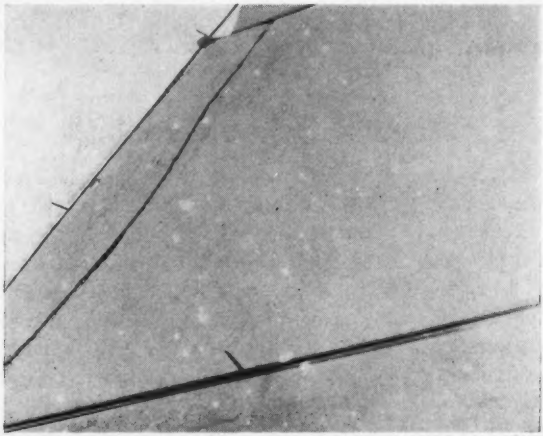
Members who listened to the story of Mr. S. C. Noland at the annual meeting in Atlanta in May will remember the exhibit illustrated above, showing what was created out of waste materials by children of the sizes and ages shown in the picture. These children were Atlanta public school pupils of varying social status. Their teacher, Mrs. Raoul, in a desire to coöperate in the fire prevention campaign of the Chamber of Commerce projected by Mr. Noland's committee, took the children for a visit to a local fire station. They were of course greatly thrilled, and a discussion in the classroom following the visit revealed a most interesting absorption of details. To fix these impressions and to clarify some of the ideas concerning these details of certain objects and their functions, the children were taken for a second visit and encouraged to ask questions that the teacher might register the correct stages of their comprehension.

The little pupils were then encouraged to act upon the suggestion of one of their number that they build a fire station and its equipment from memory. The result is indicated by the photograph. The members of the Association who examined the models at the annual meeting were exceedingly interested in the perfection of detail and the accuracy of the children's observation, not to mention the clever selection and utilization of waste materials and the ingenuity with which it was put together.

Washington Monument Lightning Protection.

By M. G. Lloyd,
(Member N. F. P. A.).

About fifty years ago the Washington Monument on the Mall at Washington, D. C., was completed, and on December 6, 1884, the block of aluminum which forms the cap of the apex was set in place. Aluminum was selected for the cap because of its whiteness, and the probability that its polished surfaces would not tarnish upon exposure to the air. The aluminum was a square pyramid in shape, nearly 9 inches high and 6 inches square. In its base a copper rod, $1\frac{1}{2}$ inches in diameter, was screwed, and this was connected inside to the four hollow wrought iron columns standing in the well of the shaft.



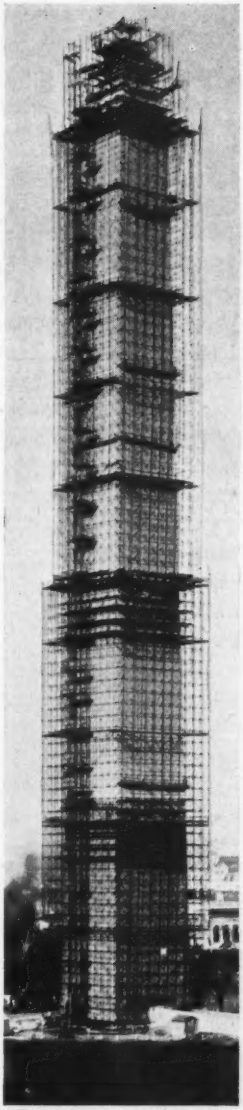
Stone near the top of the monument, cracked by lightning in 1885. This picture shows one of the corner rods and a point projecting from one of the horizontal conductors added after the damage done in 1885.

The bottoms of the iron columns rested upon and were bolted to cast-iron shoes. To the shoes were connected $\frac{3}{4}$-inch soft copper rods leading to the bottom of a well in the center of the foundation below the permanent water level. The well was afterward filled with sand.

On June 8, 1885, during a thunderstorm, the monument was struck, and upon examination, a crack was discovered in one of the stones on the north

---

This article was presented as a paper at the 39th annual meeting of the National Fire Protection Association, Atlanta, Georgia, May 13-16, 1935. (See Proceedings, printed as part 2 of this QUARTERLY, page 208). The author, chief of the Division of Safety Codes, National Bureau of Standards, is chairman of the N.F.P.A. Committee on Protection Against Lightning.

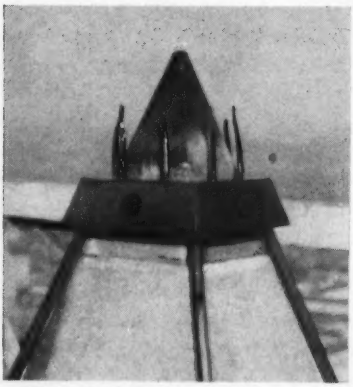


Washington Monument with scaffolding, 1934.

side, just under the top stone. One fragment was pressed outward about ¾ inch. The monument had been struck a number of times in the previous April without damage.

As a result of the above experience, Profs. Rowland, Newcomb and Mendenhall were called in and recommended a system of rods and points. A ½-inch copper rod was run down each edge of the pyramid from a gold-plated collar which rested on the aluminum. At the horizontal joints in the masonry, copper strips were run from rod to rod at 11 different levels. Both rods and strips were gold plated and were equipped at intervals with points consisting of gold-plated copper rods projecting 2½ inches from the surface. These rods tapered from ¼ inch at the base to 1/16 inch at the point, where a piece of No. 20 platinum wire was inserted to act as the electrode for any discharge. There were in all about 200 of these discharge points. In the collar resting on the aluminum cap eight similar points, slightly longer and thicker, were mounted with their axes vertical. The copper rods running down the edges of the pyramid were connected at several points through the stone to the interior iron framework.

When the scaffolding was erected to the top of the monument last year for the purpose of cleaning it, an opportunity was presented for inspecting the lightning-protection equipment. The points at the peak of the pyramid showed abundant evidence of having been struck by lightning. Several had been fused at the tip, one carrying a distinct bead of fused copper about ⅛ inch in diameter. The heat had corroded the surface somewhat and dissipated the gold, and some of the points had sagged. The tip of the aluminium was roughened and a globule of molten metal had run down one side and frozen. Several joints in the rods running down the edges of the pyramids had become loose. No damage to the masonry had



Original tips surrounding aluminum cap.

been done by lightning since this installation was made, although the monument had been frequently struck. Upon my recommendation the joints in the rods were repaired and the points at the apex replaced by longer ones which extend higher than the aluminum, so that they can be expected to receive future strokes. All missing points on the rods and horizontal strips were replaced by gold-plated copper as in the original installation. A measurement of the resistance between the collar at the apex and the iron framework inside was made after the repairs and it was found to be less than one-thousandth ohm.

Several lessons may be learned from the experience with the Washington Monument. In the first place, the so-called "cone of protection" which surrounds the metallic path to ground from an elevated conducting object is not a space which is necessarily free from strokes of lightning. Occasionally lightning strikes within such a cone, and may do damage to objects located within it.

New points extending above the cap.

In the second place, a fair approximation to a Faraday cage on the exposed sides of a structure, and the grounding of this cage, provide protection against lightning which may be rated at 100 per cent, for cases in which no explosives or flammable materials are present which might be ignited by the electric arc outside of the structure, or by induced discharges within.

In the third place, the presence of about 200 discharge points on the monument does not prevent it from being struck by lightning. The Committee on Protection Against Lightning appears to be correct when it states that the sole purpose of lightning rods is to protect a building in case a stroke occurs, there being no good reason for believing that any form of protection can prevent a stroke.

The Use of Water to Extinguish Oil Fires.

By A. L. Brown (Member N.F.P.A.),
Director, Factory Mutual Laboratories.

A statement that water can be used for the effective control of oil fires may sound revolutionary, at least to the practical fire fighter. It is only within a period of about ten years that any well-recognized authority has suggested the application of water to burning oil, beyond the use of hose streams for checking or diverting the travel of flowing burning flammable liquids, or for cooling exposed tanks of flammable liquids. Hesitation to use water on oil fires is based upon early experience in which water, as then applied, did not extinguish the fire, but often spread or intensified it.

First aid extinguishers using water alone are given no recognition for even incipient fires in flammable liquids in open vessels. The N.F.P.A. Regulations for First Aid Fire Appliances specify that for incipient fires in small quantities of flammable liquids, greases, etc. (Class B fires) a "blanketing" effect is essential. The types of extinguishers classed as suitable include carbon dioxide, carbon tetrachloride, dry chemical, foam, and loaded-steam chemicals. Observation of the behavior of these various extinguishers indicates, however, that the extinguishing effect is not necessarily one of blanketing alone.

Before reviewing developments in the use of water for extinguishing oil fires, it is instructive to consider the way in which various methods of applying *water* could be expected to control or affect a burning liquid. It is not out of place to consider also the corresponding action of other possible extinguishing liquids such as carbon tetrachloride.

It should be remembered that flammable or combustible liquids do not burn directly, but only when converted into vapor which must mix with, or make contact with, the oxygen of the air. Also, no liquid can burn unless its temperature is such that the rate of vaporization will provide sufficient fuel for continuous combustion. This tendency to vaporize is indicated by the flash point and the fire point of the liquid.

The heat of a fire once started naturally increases the temperature of the liquid up to its boiling point, after which the fire may no longer increase greatly in intensity because the heat supplied to the liquid by radiation from the fire approaches a maximum value which is balanced by the heat used up in vaporizing or boiling the liquid.

This article was presented as a paper at the 39th Annual Meeting of the National Fire Protection Association, Atlanta, Georgia, May 13-16, 1935. For discussion see Proceedings (printed as Part 2 of this QUARTERLY), page 199.

When a flammable liquid is burning, its exposed surface at least is at, or above, the temperature corresponding to the fire point. If the burning liquid can be cooled below this temperature, the fire will no longer burn.

The Action of Water on Burning Liquids.

It is possible, therefore, that water applied rapidly and effectively, might reduce the temperature of a burning oil to nearly the temperature of the water. If the oil is then below its fire point, the fire will be extinguished. This is one basis of a well-founded belief that fires in high flash point oils can be controlled by water. Inasmuch as the vaporization of water absorbs much more heat than a mere change in its temperature between any probable practical limits, it is evident that the cooling effect of water is greatest when applied to burning substances which are above its boiling point of 212° F. Consequently a high flash point oil considered from this angle is one having its fire point above 212° F.

Other actions in addition to cooling make caution necessary in applying water to oil heated above 212° F. The sudden expansion of the water into steam may produce violent spattering or foaming, and also the burning liquid may be floated or spread over a larger area before it is controlled.

Burning of a combustible vapor mixture can start or continue only above a certain critical temperature, usually designated as the "ignition temperature." Also the burning of a mixture of gas or vapor in air at atmospheric pressure produces a definite limited amount of heat. If the burning mixture is brought into intimate contact with a water spray, a considerable amount of heat may be absorbed by the water so that the flame temperature, as well as the amount of heat radiated into the burning liquid will be reduced. Also, the water vapor produced will dilute the combustible mixture somewhat and further diminish the intensity of the fire. No record has been found of work to show the importance of these effects, which by themselves are undoubtedly not a complete method of extinguishment.

Certain flammable liquids, not usually classed as oils, such as alcohols, acetone, glycerine, etc., are water soluble and are easily diluted with water. The liberation of burnable vapors from such water solutions is a function of vapor pressure—or distillation characteristics. Alcohol-water mixtures must be quite dilute in order not to burn. At a temperature of 80° F. the proportion of ethyl alcohol (grain alcohol) must not be over 50%. If such a mixture is ignited and is heated by the resulting fire, burning will continue until the alcohol content is reduced to about 15%.

A few combustible liquids such as carbon bisulphide, and some materials such as sulphur which melt or fuse before reaching a burning temperature, are heavier than water and therefore may be covered and blanketed by water if it is carefully applied with little surface disturbance. This is a true blanketing effect, and for liquids lighter than water, it is the end sought by

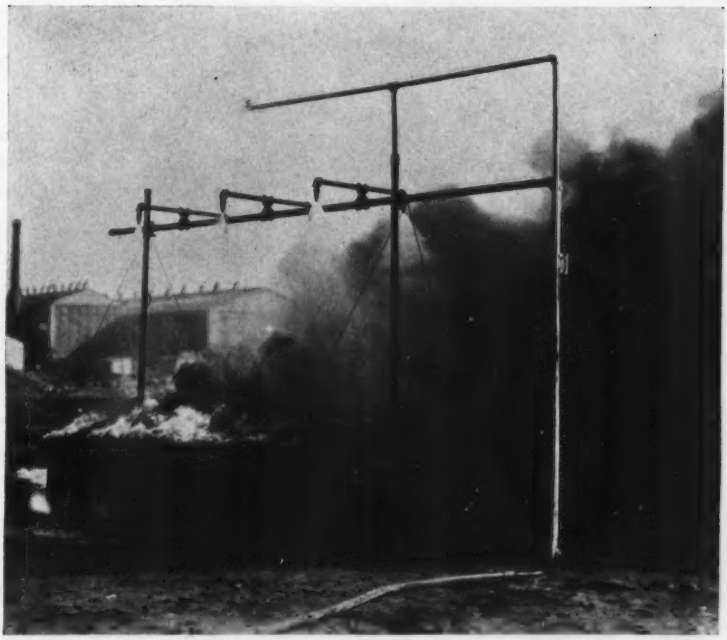


Fig. 1. Test showing carbon tetrachloride being sprayed on burning oil in a 40 sq. ft. tank.

supplying the water in a floating foamy mixture, usually produced chemically. The water seal practically prevents vaporization from the surface of the covered liquid until its boiling point is approached. The sealed-in liquid will not ignite even if well above its fire point temperature.

In the case of burning, viscous, high flash point oils, such as asphalt, the application of water produces a foam of the material and the water vapor. With the water applied rapidly in small drops, even as discharged by automatic sprinklers, the cooling effect may easily be sufficient to reduce the resultant surface temperature to below the burning point. Here again, caution is needed to guard against excessive overflow of the foam produced, and to prevent it reaching unprotected areas while still burning.

Early experimental work in the application of water spray was with water from automatic sprinklers or with the broken-up streams from hose nozzles. It was found that fires in asphalt or heavy fuel oil could generally be extinguished by water from sprinklers alone, provided that closely spaced heads with good water pressure delivered the spray in sufficient density, and that the burning material, overflowed by foaming, was confined to an area

Fig. 2. The oil fire after being extinguished by the spray of carbon tetrachloride.

fully exposed to the water protection. In the case of lighter products (even light fuel oils or kerosene) a marked reduction in flame height and intensity was obtained, and with these non-viscous low boiling point materials, foaming or serious spattering did not occur if the water was applied reasonably promptly after the start of the fire. With properly arranged overflows the burning liquid could be gradually displaced with water, and the fire eventually extinguished with little or only moderate injury to the confining building.

When this point in the investigation of the behavior of water upon oil fires had been reached about ten years ago, attention was also given to more effective applications of other extinguishing agents, particularly carbon tetrachloride.

Corresponding Action of Other Extinguishing Liquids.

Carbon tetrachloride was best adapted to immediate results in view of its greater volatility, and the greater density and extinguishing capacity of its vapors. The accompanying photographs show tests made by the Factory Mutual Laboratories in Boston about 1929 with the spray application of carbon tetrachloride to burning fuel oil. Except for the extinguishing

medium, there is great similarity between this early work and the spray application of water.

The 40 sq. ft. tank in which the tests were made contained about 150 gallons of medium fuel oil and waste crank-case oil. The carbon tetrachloride was delivered under about 50 lbs. per sq. in. pressure, from six 5/16-in. orifice spray nozzles located as shown. Fire, after being allowed to reach considerable intensity, was extinguished in a few seconds with five to ten gallons of carbon tetrachloride. Such an extinguishing effect cannot be produced by applying a corresponding amount of carbon tetrachloride in the form of a solid stream.

Consideration of this extinguishing action of carbon tetrachloride spray for flammable liquid fires makes it evident that the greatest effectiveness is undoubtedly obtainable by proper spray application.

There is little question but that the extinguishing liquid must reach the surface of the burning liquid. This requires a spray of sufficient strength or velocity to overcome the drafts and air currents produced by a fire. The spray must be sufficiently coarse, and delivered in sufficient volume, not to be dissipated by vaporization in passing through the flame and heated gases. On the other hand, the spray cannot be too coarse, and it must have only sufficient velocity to give a surface action on the flammable liquid without severe splashing or immediate penetration through the surface layer of the burning material. Water at the bottom of the combustible liquid, or even well below the surface, is of no direct benefit. Very important also is the complete coverage of all of the exposed surfaces of the flammable liquid.

With a spray having the best combination of characteristics, dependable extinguishing effects are obtained. It becomes evident, however, that this attainment is not simple, although not impractical.

The effect of the carbon tetrachloride spray is a combination of cooling of both the flame and the surface of the liquid; the production of an inert gas through direct vaporization of the carbon tetrachloride; and the dilution of the surface layer of the burning material. Inasmuch as carbon tetrachloride is miscible with most flammable liquids no beneficial emulsion is formed.

The "Mulsifyre" System.

Within the past year the "Mulsifyre" system of extinguishing oil or other flammable liquid fires, by discharging sprays of water forcibly on to the surface of the burning liquid, has received considerable publicity and has accelerated interest in the use of water for this type of hazard. This increased attention, in the United States at least, is largely the result of tests which the Grinnell Company of Providence, R. I., has carried on with the Mulsifyre system, originally developed by Mather & Platt, Ltd., of Manchester, England.

A strong spray of water applied to oils or liquids which are non-miscible

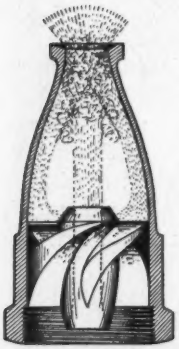


Fig. 3. A cross section of the "Spraco" spray nozzle.

with it, forms either a foam or an emulsion having a high proportion of water. Literature issued by Mather and Platt, Ltd., on the Mulsifyre system states in substance that the underlying principle is that of converting a flammable liquid into one which will not burn, by emulsifying it with water. The emulsifying action, even if transient, is given credit for the marked effectiveness of the Mulsifyre system.

Possibly, it is allowable to contemplate an application of water in such fine drops that it does not settle or penetrate the flammable liquid rapidly, thereby leaving essentially a water layer on top.

Mather and Platt first experimented with water sprays in a search for an effective means of controlling fires in alcohol or alcohol-water mixtures present in distilleries and bonded warehouses. A report issued in 1932, referring to tests made about 1925, contained the following statement: "Arising out of these tests it became clear to us that the water must be directed onto the whiskey with a certain degree of force in order to insure effective mixing, and we were quite successful in subsequent tests using various kinds of spraying nozzles to direct the water in well-broken-up, but nevertheless strong jets."

In 1927 the attention of Mather and Platt was directed to the control of fire in the boiler rooms of ships, and apparently to somewhat unfavorable results which had been obtained by others with water "Fog" systems in which a very fine spray had been used.

Later, Mather and Platt conducted a series of experiments using special sprayers on various flammable liquids. They found that if water was directed on the flammable liquid with some force in the form of fine strong jets, they could extinguish fires in fuel oil and in liquids with a flash point well below 212° F. with certainty. At this time the Mulsifyre idea was actively pursued. Mather and Platt have installed about 50 equipments in England, Ireland, France, Germany, and South America. The most important of these have been in power stations to protect oil hazards in both electrical equipment and lubricating oil systems. Within a month, a report has been received of the successful control by a Mulsifyre system of a fire in a japan dip tank at an automobile plant in France.

The Grinnell Company has made an installation to protect an asphalt saturating tank near Bridgeport, Conn., and is now working on systems to protect oil-filled transformers and high-pressure lubricating oil systems at public service power plants in New York.

The principle of the spray nozzle shown in the accompanying illustration, and of the Mulsifyre nozzle is approximately the same, in that the jet is

Fig. 4. Control of an oil fire immediately after turning on the water. The projector is discharging at about 7 ft. above a shallow pan 3 ft. in diameter. Water pressure was about 100 lbs. per sq. in.

a combination of a straight and several spiral streams which produce a moderately fine spray evenly distributed in the shape of a solid cone.

The "Projector" used ordinarily with the Mulsifyre system has a discharge orifice 5/16 in. or larger in diameter. The pitch of the spiral passages is varied to give a wide cone or a narrow cone, depending upon the height at which the projector is to be located above the hazard to be protected. This height may vary from about 5 ft. to 12 ft. Projectors must ordinarily be located not over 3 ft. apart horizontally to give the necessary complete coverage. The water discharge from the various size projectors varies from about 15 to 20 gallons at 40 lbs. water supply pressure, which is considered the lowest pressure giving an effective spray.

Fig. 5 shows a steel tank 10 ft. in diameter, about one-third full of a mixture of fuel oil and transformer oil, with seven Mulsifyre projectors located about 6 ft. above the oil surface. The very first discharge of water produces a surface agitation likely to result in an enlarged burst of flame. After this, the fire is apparently extinguished near the surface of the liquid with the formation of a cloud of white vapor. The flame then retreats farther and farther from the tank and is ultimately extinguished completely. After the fire is extinguished the oil is covered with a layer of foam, apparently resulting from air and water vapor held within oil bubbles. Some water is also carried in suspension, which is evident from pronounced sputtering when the oil is reignited.

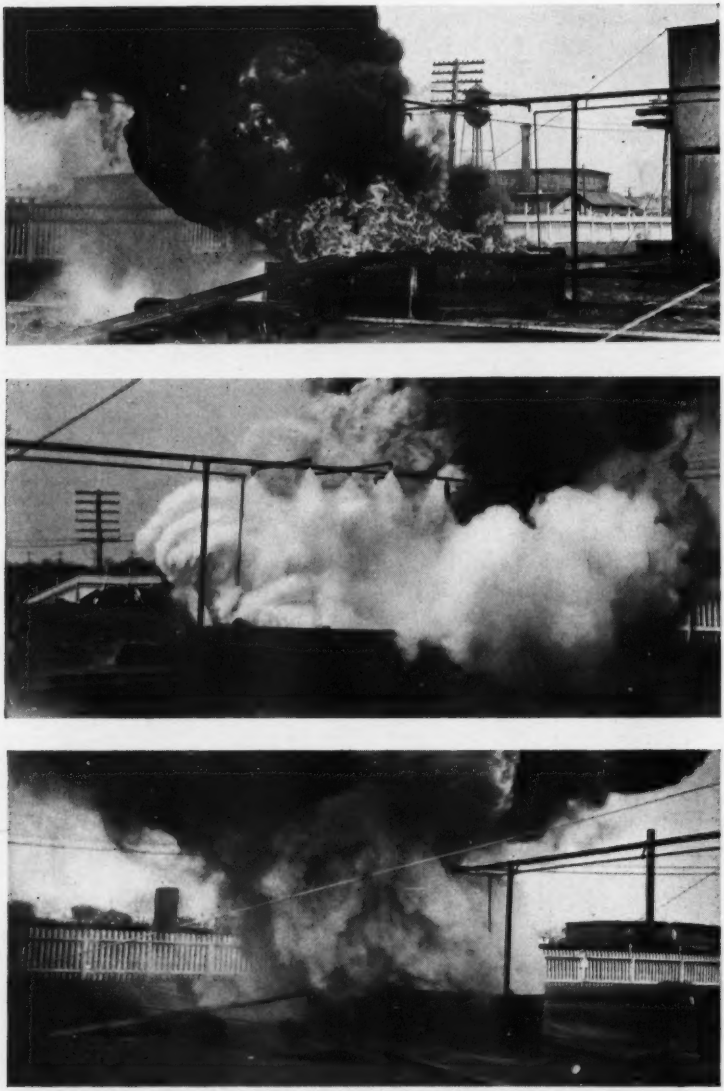


Fig. 5. The action of a Mulsifyre system on a fire in a tank of oil. Above: Before the system was turned on. Center and below: After the sprays were applied.

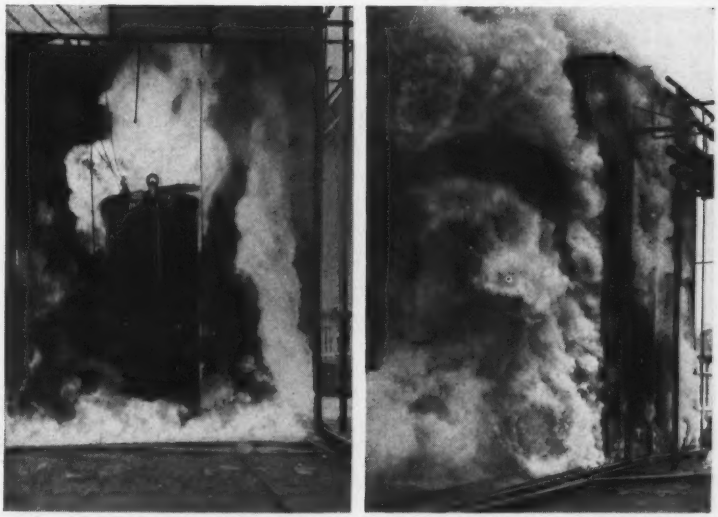


Fig. 6. Left: The 500 KVA transformer (about 8 ft. in height) on fire and test equipment just before the Mulsifyre system was turned on. Right: The extinguishing action after system was turned on.

Fig. 6 shows Mulsifyre protection for a 500 KVA oil-fired transformer within a three-sided enclosure of sheet metal and asbestos boards. Mulsifyre projectors are located above the transformers and at lower points where necessary to give good distribution over the surface of the transformer and the curbed floor within the enclosure. For these tests the oil was heated electrically within the transformer shell, and the oil outside on the floor was ignited by the addition of gasoline. After the fire was well under way water was admitted through a pipe into the bottom of the transformer to overflow the transformer oil. This fire was promptly extinguished.

Equipment arranged to represent lubricating oil piping in a large power station is shown in Fig. 7. Fire is started by igniting a pressure atomizing fuel-oil burner located near the center of the grouped elevated pipes. After the pipes are well heated, lubricating oil is allowed to escape from a slotted pipe and to discharge upon the heated pipes, producing a very hot fire as indicated. Some burning oil drops to the floor, where it continues to burn as would be expected in an actual fire. Mulsifyre projectors are located and directed to cover the entire area involved with the water spray. In this out-of-door test, it can again be observed that the flame from the oil fire is driven away from the protected area and that the oil vapors burn in the air outside of the area until the cooling effect of the water reduces the amount of vapors liberated and the fire is extinguished.

Fig. 7. Start of Mulsifyre spray on a fire in oil escaping from split lubricating oil pipe and atomizing oil burner.

Fig. 8. Mulsifyre nozzles protecting a diked area in which burning oil is retained.

An arrangement of Mulsifyre nozzles for protecting a diked area in which burning oil might be retained is shown in Fig. 8.

Fig. 9 shows a special hose nozzle giving a discharge similar to that of Mulsifyre projectors and intended for manually extinguishing small fires or

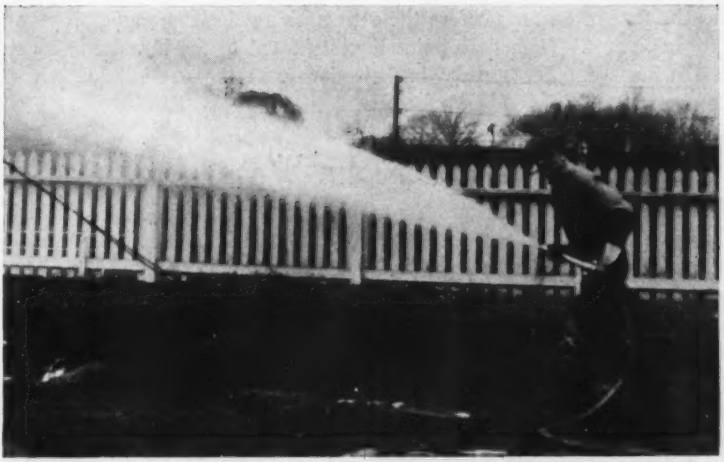


Fig. 9. Portable Mulsifyre nozzle on small hose line for manual control of small fires.

for aiding in extinguishing larger fires which might not be completely extinguished at some points by a fixed Mulsifyre system. The discharge of this size nozzle on 1½-in. hose is approximately 60 gallons per minute at 100 lbs. supply pressure.

Control of Mulsifyre equipment may be entirely manual or fully automatic by means of deluge-type control valves which can be operated by a pilot system of automatic sprinklers, either wet or dry, or remotely controlled by electric, pneumatic, or hydraulic means. Small groups of four to six nozzles are often controlled by a special valve located within the protected area and actuated by a quartz bulb. Precautions may be needed to avoid possible obstruction of the relatively small nozzle openings.

This paper is intended to be merely informative regarding recent progress in water protection for oil fires. Development work by the manufacturer is still under way and the possibilities and limitations are probably not yet fully understood. The equipment and devices used have not been submitted to approving laboratories.

In considering the value and application of this equipment, it is necessary that each purchaser or approving organization be convinced of the value of the proposed arrangement by tests or demonstrations representing actual field conditions closely enough to allow dependable conclusions. Observers should always keep in mind possible differences between experimental set-ups and actual conditions, particularly as influenced by the usual reduction in scale from the actual to the test equipment. In controlling flammable liquid

fires the time of burning before the extinguishing agent is applied is surprisingly important. High flash point liquids heated to the burning point only on the surface differ greatly in behavior from the same liquids heated throughout.

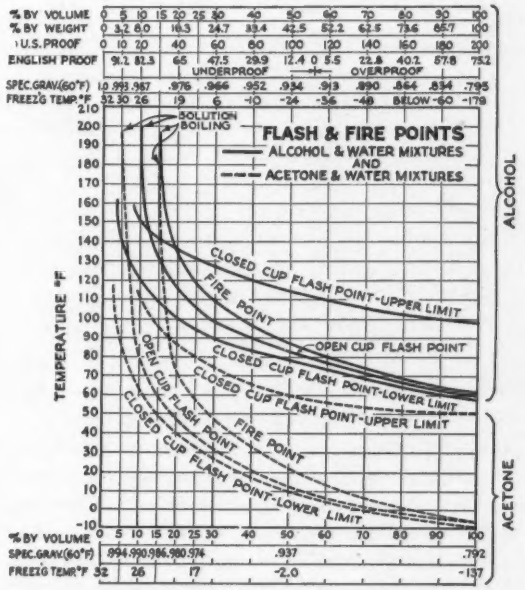
Alcohol- and Acetone-Water Mixtures.

Water is a safe extinguishing agent for fires in acetone and in alcohol, which are freely soluble in water in all proportions. The action of water in extinguishing fires in such liquids consists both of a cooling effect and dilution to reduce the combustibility of the liquid. The accompanying chart giving the flash and fire points of alcohol-water mixtures and acetone-water mixtures, reprinted from the June 1935 issue of the Factory Mutual Record, is based upon tests by the Factory Mutual Laboratories. The alcohol used in these tests was U. S. P. ethyl alcohol, not denatured. The percentage figures show the actual amount of alcohol present in the mixtures. Commercial alcohol usually contains about 4 or 5% of water. Denatured alcohol will vary somewhat from the chart, depending upon the kind and amount of denaturant used.

The chart shows that a mixture containing less than 15% of alcohol will not burn continuously even if heated to its boiling point. Any concentration of alcohol greater than 15% will burn, depending upon the temperature of the liquid. To extinguish alcohol fires with water, sufficient water must be used to cool and dilute the liquid to a point below the fire point line on the chart. A quantity of water several times the original quantity of alcohol may be necessary to accomplish this result, particularly where the fire has been burning for some time and the alcohol has become thoroughly heated. This presents a practical difficulty in the use of water to extinguish fires in large tanks of alcohol where a very large water supply would be necessary for effective extinguishing action and where the burning liquid might overflow from the tank, thus spreading fire unless some provision is made to take care of the overflow.

The chart gives other data on the properties of alcohol and water mixtures. For example, the closed cup flashpoint curve indicates that alcohol mixtures containing more than 20% alcohol stored in tanks have an explosive atmosphere above the liquid surface when the liquid is at temperatures above 60° to 100° F., depending upon the concentration of alcohol.

Similar data are given for acetone in the lower part of the chart. It is noted that with acetone-water mixtures containing more than 20% of acetone the atmosphere above the liquid level of the closed tank is too rich to explode above temperatures from 50° to 90° F., depending upon the concentration.



OPEN CUP FLASH POINT is the lowest temperature of the liquid in an open container at which the vapors above the liquid can be ignited by a spark or flame.

FIRE POINT is the lowest temperature of the liquid in an open container at which the vapors are evolved fast enough to support continuous combustion.

CLOSED CUP FLASH POINT—LOWER LIMIT is the lowest temperature of the liquid in a closed container at which the vapors can be ignited by a spark or flame.

CLOSED CUP FLASH POINT—UPPER LIMIT is the highest temperature of the liquid in a closed container at which the vapors can be ignited by a spark or flame.

At all temperatures between the Lower Limit and the Upper Limit, the vapors will flash or explode. Below, they are too lean; above, too rich.

Oregon State Capitol Fire.

Report by Oregon Insurance Rating Bureau.

(Member N.F.P.A.)

The state capitol building at Salem, Oregon, was completely destroyed by fire on the evening of April 25, 1935, with a loss of approximately $1,000,000 to building and contents. This figure does not include the cost of replacing records which were destroyed and losses due to the interruption of state governmental departments. Among the features which make this fire of particular interest are those of extremely faulty building construction, which caused this important public building to become a total loss in a very short time, the destruction of valuable public records stored in ordinary filing cabinets and the preservation of all records stored in vaults. No fire insurance was carried by the State of Oregon and a small self-insurance fund proved entirely inadequate. (See Frontispiece.)

Construction of the Building.

The capitol was a three-story and basement structure, seventy-one feet high, covering an area of 19,000 square feet and was completed in 1876. The building was in the form of a cross, approximately 260 feet long and 155 feet wide, and was surmounted by a dome, the top of which was 186 feet above the ground level. The type of construction was typical of many public buildings erected in the latter half of the previous century. Although giving the appearance of permanence and solidity it embodied many features of construction which are now regarded as violations of good building practice. Exterior walls were of substantial brick with plastered or stuccoed exterior, but at the tops of the walls were wide metal covered frame cornices. Numerous brick division walls separated the interior into sections, but the walls did not extend through the attic or roof and all were pierced by large unprotected openings. On the interior of the outer building walls and some division walls were false walls of wood lath and plaster on furring and studding.

Floors were of wood on heavy joists, forming deep channels. Joist channels and false walls were without firestops. Floor joists were variously supported by walls, wrought iron beams, and both wrought and cast iron columns. Where steelwork was covered it was with metal lath and plaster in some instances and by wood panels in others. Unprotected vertical openings consisted of stairways open at all floors, the dome forming an open light-well above the first floor, and an elevator in a masonry shaft open on each floor. The top of the elevator shaft opened into the attic space below the joisted metal covered roof. The dome was of skeleton steel construction, independently supported by four pairs of latticed steel columns. These columns had

been enclosed with wood paneling to give the appearance of pillars. In the fire these acted as flues to carry the fire to the upper portions of the structure. The paneling had the further effect of concentrating the heat and flames upon the steel columns, hastening their failure and the collapse of the dome. The basement, where the fire was first discovered, was ceiled with three-quarter inch matched lumber, placed directly on the bottoms of floor joists without fire stopping.

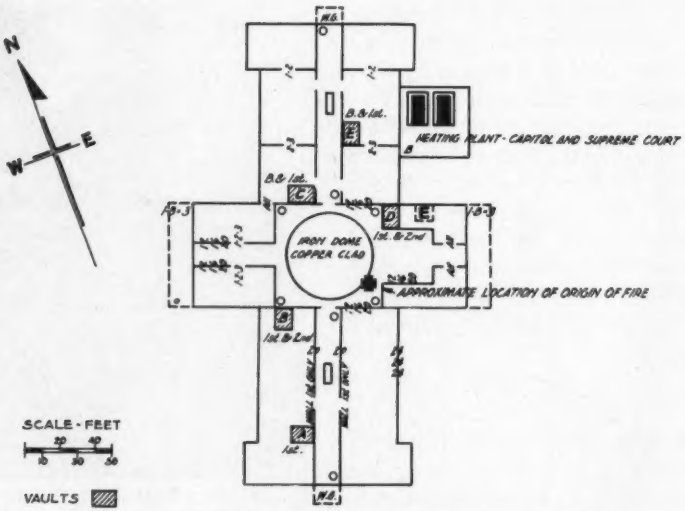
The Oregon State Capitol before the fire. The imposing exterior gave no indication of its combustibility. (See Frontispiece.)

Occupancy.

The first floor of the capitol was principally occupied by the offices of the secretary of state, state treasurer, board of control, and tax commission. These departments used the basement below their offices for storage of records. Under the rotunda and in the east wing of the basement were the janitors' quarters, a waste paper baling room, a small kitchen and lunchroom. The governor's office, banking department, house and senate chambers occupied the second floor. The third floor was given over to state departments, including education, police, forestry, and labor.

Story of the Fire.

The fire was discovered almost simultaneously by persons inside and outside of the building. The first alarm was received at fire headquarters by telephone at 6:43 P.M. from a near-by resident and was followed immediately by alarms from employees in the building. A janitor detected smoke and found that the fire was in the east basement wing and that smoke and heat had already filled the waste paper baling room. In about three minutes the first fire companies arrived and additional apparatus was promptly called. Two hose lines were taken into the basement, but soon had to be withdrawn because of the intense heat. Considerable smoke was encountered and the exact location and extent of the blaze could not be determined. Moving to the first floor, firemen found flames ascending the paneled pillars enclosing the steel columns supporting the dome. The fire spread rapidly and is reported to have been observed issuing from the wooden cornices within five minutes after the arrival of the first equipment. By this time four pumpers and an aerial truck were in operation. The fire quickly spread to all floors.



Plan of the Oregon State Capitol, showing location of vaults.

About 8:00 P.M. the dome collapsed. It was caught by the division wall on the south side of the rotunda, in which position it remained. About twenty minutes later a call was sent to the Portland fire department fifty miles distant, which responded with two pumpers and a turret truck. With this equipment in operation a total of seventeen streams were employed. The building was practically destroyed within three hours after the fire was discovered, but hose streams were kept playing into the blazing débris well into the next morning. Some of the record vaults were not opened until May 7, due to the amount of débris which had to be removed. One fireman, a university student who worked nights with the fire department, was killed by a falling cornice. Apparently few, if any, of the firemen fighting this fire wore the regulation firemen's helmets.

The water department, upon notification of the fire, placed pumps in service to increase the supply of water available and shut off service to the outlying residential districts. Approximately 3,500,000 gallons of water were used. Hydrants nearest the building were supplied by six-inch mains. Additional water would have been of material assistance in reducing the loss in those portions of the buildings more remote from the origin of the fire.

Construction and Location of Vaults.

The building contained eight record vaults of varying construction. None of the vaults were of modern design, but all preserved their contents, which included most of the more vital records and documents of the state. A larger

The dome collapsed after the fire had been burning an hour and a quarter, the unprotected steel supports weakened by the intense heat.

A typical view of the ruins, showing the wood lath and plaster walls with concealed spaces through which the fire spread.

part of the state records, however, were stored in ordinary filing cabinets and were destroyed. Four of the vaults were constructed when the building was built and four were erected twenty to twenty-five years ago.

The vault doors, while erected at different periods, were all of the same type. Outer doors were of ½-inch sheet steel and inner doors were of ¼-in. sheet steel. There was a twenty-inch air space between the inner and outer doors of all vaults, except those listed as "D" on the accompanying table, which had a thirty-six inch air space between the doors. The large amount of water played on the fire from all sides, while not adequate to extinguish the blaze, was undoubtedly an important factor in preventing the failure of the vault doors.

The contents of two vaults located in the basement were damaged by water and resulting steam, but were legible after drying. Water reached a depth of twenty-seven inches in one of these vaults and twenty inches in the other. A table showing the location, occupancy, construction and effective-

Data on Vaults.

Vault No.	Location	Occupancy	Area	Walls	Roof	Age of Vault	Result	Remarks
A.	First floor, south wing.	Tax Commission.	7′x14′	2.12″ brick 2.12″ concrete	Concrete slab.	20-25 years.	Contents in good condition. Slight moisture damage. Paint on inside of inner door blistered.	Poorest constructed vault and subjected to greatest exposure.
B.	First floor, south wing.	Tax Commission.	8′x14′	24″ brick.	24″ brick arch.	60 years.	Contents in good condition. No evidence of heat or moisture.	Vault filled to within 6″ of outer door during fire. Inner door could not be closed.
B.	Second floor, south wing.	Banking Department.	7′x14′	24″ brick.	24″ brick arch.	60 years.	No damage to contents. Paint on inside of inner door blistered.	Under great exposure. Bolt on door warped.
C.	Basement to second floor, north wing.	Secretary of State.	12½′x13′	24″ brick.	24″ brick arch.	20-25 years.	Paint on inside of inner doors, ends of books in basement blistered. 27″ of water in basement caused steam damage. Contents legible after drying.	Vault had inside metal stairway. Entrances to vault from basement and first floor only.
D.	First floor, center section.	Land Board.	10′x14′	24″ brick.	24″ brick arch.	60 years.	Contents not damaged.	Not subjected to great exposure.
D.	Second floor, center section.	Budget Department.	9′x9′	24″ brick.	24″ brick arch.	60 years.	Contents not damaged.	Under considerable exposure.
E.	Basement, north wing.	State Treasurer.	9′x14′	24″ brick.	24″ brick arch.	20-25 years.	20″ water in vault. Contents legible after drying.	
E.	First floor, north wing.	State Treasurer.	9′x14′	24″ brick.	24″ brick arch.	20-25 years.	Contents not damaged.	

ness of the vaults has been prepared. The location of the various vaults is also shown on the building plan on page 44.

Records Destroyed.

As has been mentioned, a large portion of the basement of the capitol was used for the storage of department records. These records, aside from those in the vaults, were stored in ordinary filing cabinets. While most of the essential current records destroyed are replaceable from district offices, considerable labor will be involved in assembling this material. Many records destroyed, while not essential to departmental operation, were nevertheless of historic interest and are irreplaceable. The various governmental departments which lost records are given below.

Loss of Records.

GOVERNOR'S OFFICE: All records lost. Mostly correspondence, applications for positions, governor's bookkeeping system. Necessary records replaceable from other departments. Historical letters lost.

BUDGET DIRECTOR'S OFFICE: Inventories, salary schedules and correspondence lost. Inventories and salary schedules available from district offices. Correspondence was in ordinary filing cabinets, not replaceable. Loss has slightly handicapped department.

BOARD OF CONTROL: All collection records lost and no duplicates available. New records being made from listings in institution records. Ledgers, contracts, and bonds in vault were saved. Operations of department not materially affected.

SECRETARY OF STATE'S OFFICE: Index cards, financial records, old records and vouchers of little value were destroyed. All laws and permanent records were in vault and were not destroyed. Some will have to be rebound and copied. Loss did not handicap operations of the department.

STATE TAX COMMISSION—Income Tax Department: Current income tax records lost, but tax ledgers with list of taxpayers and amounts paid or due were saved.

Utility Tax Department: All completed reports were destroyed. New reports can be made from work sheets and statistical records which were saved.

Property Tax Department: All business, city and county re-assessment blanks were saved. In about six months the department will be able to function normally.

FORESTRY DEPARTMENT: All plat records lost. Duplicates obtained by copying files of U. S. Forest Service, County Records and Experiment Stations. Correspondence, vouchers and ledgers in safe for the years 1933, 1934 and part of 1935 were damaged, but are usable. Correspondence and vouchers prior to 1933 were lost and are not replaceable, but are not necessary for departmental operations. Department is greatly handicapped.

STATE POLICE DEPARTMENT: All records were lost, but can be largely replaced from information in district offices.

STATE LAND DEPARTMENT: Records destroyed were mostly correspondence of little value. All deeds, plat books, original mortgages, notes and bonds from the organization of the state to the present were saved.

LABOR COMMISSION: All records were lost and no duplicates are available. The department is functioning with no past history.

STATE BANKING DEPARTMENT: Confidential examination reports on banks were lost and copies are not available. Bank liquidation records are replaceable from county court and field offices. Lost records will not affect operation of the department except that the record history will be incomplete.

LIQUOR CONTROL COMMISSION: All permanent records were saved. These records were in a class "B" Underwriters' safe (filing cabinet type), which hung on a ledge of the building walls and preserved its contents. All records of individual liquor permits and licenses were lost, but copies are available. License applications with accompanying payments amounting to over $2000 were lost, but new applications are being made. The department is very little inconvenienced.

Cause and Loss.

The cause of the fire has not been determined, but the fire apparently originated in the basement near the janitor's quarters, waste paper baling room, and kitchen. It is quite likely that some hazard connected with these occupancies may have been the cause.

An appraisal of the capitol property made ten years ago placed the value of the building at approximately $485,000. It is estimated by state officials that the furniture and fixtures at the time of the fire had a value of about an equal amount. It is not expected that the loss on the building, furniture and fixtures will be in excess of $1,000,000. This does not, however, include the expense that will be involved in replacing much data essential to the conduct of the state's business. No insurance against fire was carried by the state. Instead a restoration fund created by assessments against all state activities and administered by the board of control was in operation. The fund was reported to amount to approximately $139,000 at the time of the fire, an amount obviously inadequate for this emergency.

Paint and Lacquer Spraying Fire Record.

The following record of fires in connection with the spray application of flammable finishing materials is a compilation of the fire reports filed with the N.F.P.A. Department of Fire Record during the five-year period 1930-1934. This record brings up to date the previous fire record on the spray process published in the October, 1930, QUARTERLY, page 131, covering the five-year period, 1925-1929. A comparison of the present and previous experience shows a relative decrease in the losses attributed to the paint spraying process and presumably reflects better observance of the various safeguards for this process recommended by the N.F.P.A.

One hundred and forty-three fires are included in this analysis. These reports have been extracted from a total of approximately 15,000 reports of fires in industrial occupancies where the paint spraying process is employed. The fires included in this record are by no means all the fires that have occurred during the period covered, but furnish a typical cross section of fire experience from which conclusions may reasonably be drawn. If reports were included on the numerous minor fires which are extinguished with negligible loss and are not reported the relative fire experience might appear more favorable.

It will be noted from a study of this record that in almost every instance the fires resulted in failure to observe one or more of the good practice recommendations contained in the Regulations for Paint Spraying and Spray Booths prepared by the N.F.P.A. Committee on Manufacturing Hazards. Furthermore, it appears that serious fires were in practically every instance chargeable not only to neglect of standard fire prevention precautions, but to failure to follow the N.F.P.A. committee recommendations for fire-resistive construction, automatic sprinkler protection and appropriate separation of the paint spraying process from other buildings or sections containing valuable contents.

The nature of the flammable finishing material involved in the fires contained in this record is shown by the table on the following page.

The point of origin of these fires is given below. It will be noted that over three-fourths of these fires, or 75.5%, started in spraying equipment, such as booths, hoods, or vent ducts. Other fires occurred in spray rooms or outside of the building. The outside fires were due to the ignition of accumulations of residue deposited on roof or sides of building by exhaust systems or ignitions of scrapings from spray booths not properly disposed of. While such fires occurred outside of spraying rooms, they are directly attributable to the spraying process and were therefore included in the record.

Point of Origin of Fire.

Origin	Lacquer Spraying	Paint Spraying	Lacquer & Paint	Misc. & No Data	Total
Spray hood, booth, or vent ducts	56	15	10	27	108
Spray room fires, spread to booth	4	0	0	1	5
Spray room fires; booth not involved	2	1	0	1	4
Spray room fires; no data as to spread to booth	10	1	1	2	14
Fires in residue outside of spray room, on roof and in yard	9	2	0	1	12
Total	81	19	11	32	143

Flammable Finish Involved.

Finish	No. Fires	Per Cent
Lacquer	81	72.3
Paint	19	17.0
Paint	8	
Varnish	4	
Japan	3	
Enamel	2	
Shellac	1	
Enamel and Varnish	1	
Lacquer and Paint	11	9.9
Anti-rust liquid (benzine thinner)	1	.8
Total known data	112	100.0
Data incomplete	31	
Total	143	

The widespread use of the spray method is illustrated by the varied types of occupancies where fires have occurred. Practically every major division of industry where finishing work is done is represented in the record.

Occupancies in Which Fires Occurred.

Occupancy	Fires Reported
Automobile Mfg. and Body Plants	17
Automobile Paint Shops	1
Basket Factories	5
Doll Factories	7
Electrical Appliance Mfg.	15
Furniture Mfg.	36
Hat Factories	7
Leather Mfg.	9
Light Metal Workers	21
Radio Equipment Mfg.	2
Woodworking Plants	8
Miscellaneous Mfg.	15
Total	143

Causes of Fires.

The causes of the fires involved in this record are shown in the accompanying table. The known causes of fires have been divided into four major groups. These are electrical causes, spontaneous ignition, careless operation and maintenance, and miscellaneous known causes.

Causes of Fires.

Electrical Causes.	In Spray Booth	Spread to Booth	In Spray Room	Booth not Involved	Outside Spray Room	Total
Spark or short circuit, defective connections, motors, switch..	16	..	1	..	..	17
Spark or short circuit at fan motor	12	..	..	..	..	12
Overheated motor	3	..	..	..	..	3
Spark from broken light bulb..	2	..	..	..	..	2
Spark from electric socket.....	2	..	..	..	..	2
Spark from electric drill.....	1	..	..	..	..	1
Short circuit of spraying brush being cleaned with thinner...	1	..	..	..	..	1
Spark from spraying machine..	1	..	..	..	..	1
Spark from blown fuse ignited vapor	1	..	..	..	..	1
Spontaneous Ignition.						
Residue and/or dust.....	13	..	1	..	3	17
Oily rags, waste, scrapings from booth	6	..	3	3	4	16
Residue of mixed paints and lacquer	3	..	..	..	..	3
Careless Operation and Maintenance.						
Metallic spark ignited vapors or residue	3	..	2	..	..	5
Sparks from friction due to scraping booth in cleaning...	4	..	..	..	..	4
Smoking—matches	2	1	..	..	1	4
Sparks from acetylene torch ignited residue	3	..	1	..	..	4
Vapor ignited from open gas flame	2	..	2	..	..	4
Metallic spark from fan blade..	4	..	..	..	..	4
Blow torch used for repairs ignited residue	2	..	1	..	..	3
Metallic spark ignited residue or vapors during repairs, etc....	1	..	1	..	..	2
Soldering iron ignited residue..	1	..	..	..	..	1
Overheated bearing on fan ignited residue	1	..	..	..	..	1
Lacquer dust ignited by steam heaters	..	..	..	1	..	1
Pot of heated rosin left in booth ignited residue.....	1	..	..	..	..	1
Turntable from booth placed against radiator	..	1	..	..	..	1
Fan broke loose.....	1	..	..	..	..	1
Miscellaneous.						
Static spark	3	1	..	..	..	4
Spark from locomotive.....	2	..	..	..	1	3
Spark from rubbish in yard...	..	..	..	..	1	1

Miscellaneous, Con't.	In Spray Booth	Spread to Booth	In Spray Room	Booth not Involved	Outside Spray Room	Total
Spark from chimney	..	..	..	..	1	1
Partly slaked lime in yard	..	..	..	..	1	1
Drying oven fire spread to booth	..	1	..	..	..	1
Firecracker thrown into vent duct	1	..	..	..	..	1
Lightning ignited vapor	..	..	1	..	..	1
Undetermined.						
Booth not operating at time of fire	2	..	..	..	..	2
Booth being cleaned	1	..	..	..	..	1
No data	13	1	1	..	..	15
Total	108	5	14	4	12	143

Electrical Fires.

The following brief summaries of typical fires of electrical origin indicate in every instance that the start of the fire was directly associated with some electrical feature not in accordance with N.F.P.A. recommendations. The Regulations on Paint Spraying and Spray Booths provide that there shall be no electric motors or electric equipment of any kind inside booths or ducts. Failure to observe this recommendation is the most frequent cause of fires of electrical origin.

JANUARY 21, 1931. SEATTLE, WASH. FURNITURE FACTORY (H-30913). Fire occurred in the finishing room of an unsprinklered frame factory, when vapor from a paint spray gun was ignited by the arcing of a motor in the ventilating duct from the spray booth. Due to lack of proper cut-offs, fire destroyed the building and spread to adjoining property, causing a total loss of $64,000.

SEPTEMBER 21, 1931. PEABODY, MASS. LEATHER FACTORY (H-34042). Fire was caused by a spray booth fan motor which was located in the booth vent duct and was loaded with lacquer residue. Employee started the booth fan for the day's work and almost immediately on throwing the switch, fire started at the motor and quickly spread through the lacquer residue in the booth and its vent duct. The fire department used several small streams in extinguishing the fire. Loss $100.

APRIL 8, 1932. SYRACUSE, N. Y. METAL WORKER (S-61450). Fire occurred in a lacquer spray booth while the booth was being cleaned. A spark from electrical apparatus operating the motor for a turntable inside the booth probably caused the blaze. One sprinkler and a foam extinguisher controlled the fire. Loss $100.

FEBRUARY 22, 1933. NEW YORK, N. Y. ELECTRICAL APPLIANCE FACTORY (S-63353). A short circuit of an electric light wire run through a hole in the metal hood started a fire in the hood. An automatic sprinkler held the fire in check until a hose stream was brought into play. The loss was moderate.

Spontaneous Ignition.

Thirty-six fires are attributable to spontaneous ignition and comprise 28.8% of all fires of known cause. Leading in this group was the spontaneous ignition of paint and lacquer residue and dust in booths and ducts, which

caused seventeen fires, showing the need of frequent and thorough cleaning. Ignition of oily rags, waste and scrapings from booths caused sixteen fires, illustrating the necessity for prompt disposal of such material by removal from the premises. In several instances such materials were left outside of buildings, but were not in proper metal receptacles and spontaneous ignition started fires which communicated to the buildings. Spontaneous ignition due to use of mixed paint and lacquer where different finishes are used at the same booth was responsible for three fires. The comparatively small number of fires from this cause is believed to indicate that the danger of spontaneous ignition as a result of using different finishes at the same booth is generally realized and that care is being taken to thoroughly clean booths when it is necessary to apply another finishing material.

The following fires are typical of those resulting from spontaneous ignition.

JULY 6, 1930. NEWARK, N. J. JEWELRY FACTORY (H-30842). Lacquer residue from the spray booth was left in an uncovered metal can near the finished stock storeroom. Fire started during the night and caused $2500 damage to building, considerable loss to contents, and required the use of four hose streams.

NOVEMBER 17, 1932. SPRINGFIELD, MASS. FURNITURE FACTORY (S-62723). Lacquer residue was removed from spray booths, but was carelessly left in a pile of waste paper on the floor overnight. Fire started due to spontaneous ignition, but was promptly extinguished by the operation of an automatic sprinkler.

FEBRUARY 24, 1933. STATESVILLE, N. C. FURNITURE FACTORY (S-63388). Fire started in the finishing building due to spontaneous ignition at spray booths where both lacquers and resin base materials were sprayed alternately and booths were not cleaned regularly. Vapor had accumulated in the room after the exhaust fans were shut down for the night and an explosion or flash fire opened nearly three hundred sprinkler heads in the room, which overtaxed the inadequate water supply. Owing to inferior construction and lack of cut-offs the fire spread to other parts of the plant. The loss was $388,000.

JUNE 15, 1933. PEABODY, MASS. LEATHER FACTORY (5-63857). Lacquer residue, which had accumulated on the ground under vents from spray booths, ignited spontaneously. Fire entered ducts and flashed to spray room, where ten sprinklers opened and controlled the fire.

JULY 1, 1933. THOMASVILLE, N. C. FURNITURE FACTORY (S-63923). Fire originated in the factory yard, due to spontaneous ignition of waste paint residue from spray booths and rubbing rags. Heat from the blaze ruptured several drums of finishing material, spreading the fire to the unsprinklered space under the building. A loss of $40,000 resulted.

MAY 2, 1934. GALT, ONT. CASKET FACTORY (S-67075). Fire started in vent pipe from lacquer spray booth, due to spontaneous ignition induced by the heat from the sun. Fire flashed back into the booth. Eleven sprinklers and chemicals were used to extinguish the blaze. Loss $480.

Careless Operation and Maintenance.

The third group of fire causes, those grouped under Careless Operation and Maintenance, is of equal importance with Spontaneous Ignition, having likewise a total of thirty-six fires. In this class are also numerous fires which have resulted from failure to observe precautions outlined in the good practice requirements, such as fires caused by use of scraping knives of a type that gives sparks, and failure to maintain paint or other non-sparking lining of booths. Unsuitable exhaust fans which get out of line and strike sparks are among the causes of fires in this group. While ordinarily smoking is considered as a common hazard, it is very dangerous where flammable finishes are involved, and fires due to careless smoking have been included with careless operation and maintenance. Typical fires have occurred as follows:

FEBRUARY 17, 1930. LYNN, MASS. ELECTRICAL APPLIANCE MFG. (S-52529). Operator was removing wrapping paper used to catch residue on the floor of booth, when a knife fell from his pocket, striking a spark on the floor. Solvent vapors from wet lacquer, which had accumulated under a spray gun, ignited. One sprinkler extinguished the fire with a slight loss.

APRIL 29, 1930. NEW YORK, N. Y. ENAMELING PLANT (S-53184). Fire occurred when a spray nozzle was struck against metal plates, causing a spark. Nine sprinklers extinguished the fire.

MAY 12, 1931. GARDNER, MASS. FURNITURE FACTORY (S-56922). Fire in spray booth was caused by an overheated fan bearing igniting lacquer residue in a booth normally used for varnish spraying, but which was in use for lacquer spraying, due to a rush order. Seven sprinklers extinguished the fire, but a loss of $5,737 occurred, mostly from water damage.

OCTOBER 11, 1931. NEW YORK, N. Y. FURNITURE FACTORY (S-59530). Fire occurred in lacquer spray hood when a metal scraper, being used for cleaning, caused a spark which ignited dried lacquer residue. Two sprinklers extinguished the fire.

JULY 6, 1932. ILION, N. Y. METAL WORKER (S-63782). Fire originated in a Japan spray booth, due to a spark struck from a blade of an exhaust fan which was out of line. One sprinkler and chemical extinguishers controlled the fire with small loss.

AUGUST 15, 1932. PHILADELPHIA, PA. LAMP SHADE FACTORY (S-63391). An employee was soldering a piece of sheet metal to the frame of a spray hood and the hot soldering iron ignited lacquer residue. Four sprinklers extinguished the fire with moderate loss.

NOVEMBER 28, 1932. BROOKLYN, N. Y. METAL WORKER (S-62515). Fire occurred in spray room when lacquer residue was ignited from a blow torch which was used to repair a fan at the ceiling. One sprinkler extinguished the fire.

JULY 21, 1933. NEW YORK, N. Y. AUTOMOBILE BODY FACTORY (S-64399). Fire occurred in a spraying hood in a spray room, due to sparks from fan. One automatic sprinkler confined fire to booth.

Miscellaneous Causes.

The fires of known cause not included in the above classes have been grouped under the heading Miscellaneous. Outstanding among these are the

ignition of residues or flammable vapors by static sparks, and by sparks or heat from external sources, such as locomotives and chimneys. Such sparks found ready fuel in exposed finishing material residues and vapors, and shows the necessity of thorough cleaning and ventilation especially before plants are closed. The following fires are typical.

JUNE 8, 1933. NEW TORONTO, ONT. LEATHER FACTORY (S-65742). A metal exhaust duct from two lacquer spray booths passed through the wall of a one-story spraying section and extended up outside wall to a point eight feet above the roof. Fire originated in lump lime, which on account of having become partly air slacked was useless for dehairing and was dumped in the yard against the bottom of the exhaust duct. The lime heated and ignited lacquer deposit in the duct. Fire extended through ducts into the spray booths, where three sprinklers opened. Chemical and foam extinguishers, together with a hose stream, extinguished the fire. Loss $400.

JULY 16, 1933. UNION CITY, PA. FURNITURE FACTORY (H-37153). Fire started in the finishing room, which was closed over Sunday and left without ventilation. Lacquer thinner evaporating from furniture sprayed the previous day accumulated and reached an explosive mixture. Ignition was attributed to an induced spark from lightning. The vapor exploded, blowing out one wall and spreading fire through the building, causing a loss of $150,000.

SEPTEMBER 10, 1931. MCGRAW, N. Y. WOODEN BOX FACTORY (S-60360). A locomotive spark ignited lacquer residue discharged on the ground outside the lacquer spray room. Fire flashed through discharge pipe and ignited a stock of boxes near the spray booth. Thirty-two sprinklers and one hose stream controlled the fire. Loss $1,500.

A comparison of the causes of fires as shown in this five-year period with the record for the former five-year period as recorded in the October, 1930, QUARTERLY is interesting. In the former record 42.6 per cent of the fires of known cause were due to electrical causes, while in the present record but 32 per cent of the fires were due to such causes, a decrease of over ten per cent. The percentage of fires due to spontaneous ignition and to careless operation and maintenance increased four and five per cent respectively. This possibly reflects a tendency toward carelessness due to the period of comparative industrial inactivity.

Loss Experience.

Exact loss data for individual fires are limited, as a number of the fire reports do not give exact loss figures. It is encouraging to notice, however, from the data available, a marked decrease in the number of large losses reported as compared with the earlier record. In the present record only eight fires, or 7.2% of those of known loss, caused losses in excess of $10,000. This compares with twenty-eight losses of equal extent, or 16.8% of the known loss fires, in the previous record. Similarly where exact data were not available there was but one fire reported as "large" as compared with eleven in the former record. The fire loss records for both periods are shown in the following table.

Losses.

Loss	1925-1929 No. Fires	%	1930-1934 No. Fires	%
Small or under $1,000	104	62.8	87	79.2
$1,001 to $10,000	34	20.4	15	13.6
$10,001 to $25,000	11	6.6	2	1.8
$25,001 to $50,000	5	3.0	1	.9
Over $50,000	12	7.2	5	4.5
Total Known Losses	166	100.0	110	100.0
Moderate, no exact figures	10		27	
Considerable, no exact figures	6		5	
Large, no exact figures	11		1	
No data	1		0	
Total	194		143	

Extinguishing Methods.

The final table is presented to show methods used in extinguishing fires. It can be readily seen that while almost every form of standard protective equipment has been used, automatic sprinklers are relied upon as the principal protection against the severe hazards incident to the spray finishing operation. Sprinklers operated in over eighty-five per cent of the fires and in thirty-eight per cent of the cases completely extinguished the fire before other equipment was brought into play. The value of complete sprinkler protection, including spray booths and exhaust ducts, is thereby illustrated. Foam, chemical and carbon dioxide extinguishers also proved valuable aids for controlling finishing room fires, and were used in numerous fires to assist sprinklers or hold the fire in check until the fire department arrived.

Methods of Extinguishment.

Agent Used	Alone	With Other Agents	Total
Sprinklers	46	75	121
Fire department hose streams	3	34	37
Fire department booster lines	2	4	6
Fire department chemical lines	0	2	2
Chemical extinguishers	1	31	32
Foam extinguishers	3	23	26
Foam generator	0	1	1
Foam engine (40-gallon)	0	2	2
Private hose streams	0	10	10
Standpipe or hand hose	0	6	6
CO_2 extinguishers	0	3	3
Sand pails	0	3	3
Deluge sprinkler system	0	1	1
Open sprinklers (manual)	1	1	2
Burlap bags	0	1	1
Hand pumps	0	1	1

Spontaneous Ignition of Chopped Hay.

By Harry E. Roethe, Max A. Bradshaw and Ernest J. Hoffman,*
Chemical Engineering Division, Bureau of Chemistry and Soils,
U. S. Department of Agriculture.

Although reports of barn fires caused by the spontaneous ignition of hay are frequent, investigations made of such fires are for the most part "post mortems" because in most cases the structures and the hay have been destroyed by the fire. During the summer of 1934 the opportunity was afforded to investigate a barn fire on the Java Farm near Mayo, Maryland, and after the fire to examine the hay stored in the barn, which had undergone spontaneous heating and ignition. This fire occurred on July 20, and resulted in a loss of about $10,000. Although the roof and upper part of the barn were destroyed, little of the hay was burned by the fire.

Type and Contents of Barn.

The barn was a T-shaped structure two stories high, consisting of one section 90 ft. long and 40 ft. wide, and a shorter section 45 ft. long and 40 ft. wide joined to the longer section (at the middle) on the south side. The ground floor of the main section in which the fire originated was used for a stable, the upper or mow floor for the storage of hay. Both floors were of concrete; the walls were of hollow tile stuccoed on the outside; the gambrel roof was covered with asbestos shingles and was equipped with two ventilators. The approximate height of the stable was 9 ft., and that of the upper story or mow was 24 ft. at the ridge. (See Fig. 1.)

Fig. 2 shows the plan of the mow floor, which was equipped with a hatch, about 6 ft. by 8 ft. There was a double 8-ft. sliding door at each end of the mow. The floor area has been divided into three areas to represent the location of the different hays in storage. The dotted lines are imaginary, there being no partitions separating the designated areas.

Section A represents chopped alfalfa, first cutting, 1934 crop, which had been blown into the barn the last of May or first week in June.

Section B contained about 9 ft. of chopped alfalfa, 1933 crop. In July 1934, several feet of chopped alfalfa, second cutting, was blown into the mow on top of this 1933 hay. The remainder of the second crop, 1934 alfalfa, was sacked and stored in Section C. Several feet of chopped oat hay, 1934 crop, was blown on top of the second cutting alfalfa in Section B. Some of this

*The authors desire to express their appreciation to Mr. R. L. Forrest, owner and manager of Java Farm, for his helpful coöperation and courtesies extended during the course of this investigation.

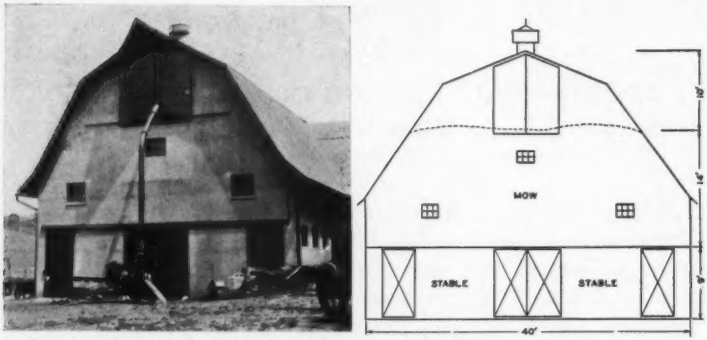


Fig. 1. View of the barn from the west, taken before the fire, showing the asbestos shingles, stucco siding, double mow doors, and hay chopper. At the right is shown the end elevation of the barn.

chopped oat hay naturally worked its way over into Section A, forming a relatively thin layer on top of the first cutting alfalfa already stored. The alfalfa of the 1934 crop contained some timothy and Alsike clover.

The total quantity of hay in the mow was approximately 200 tons. The height of the mow at the time of the fire was about 14 ft. After the hay had been placed in the barn all doors and windows in the mow were kept closed to exclude as much outside air as possible.

No information was available on the moisture content of the hay when stored. Mr. R. L. Forrest, owner and manager of the dairy farm, stated, however, that in his estimation all the hay put into the barn was adequately cured when chopped, with the exception of some of the first-cutting alfalfa, which had been rained on in the field. He also advised that the barn roof was not in the best condition at certain places on the north side, which may have resulted in leakage of rain on some of the hay.

Story of the Fire.

Mr. Forrest first noticed that the hay was heating abnormally on the morning of July 20, when he had occasion to go up into the mow. He observed that the hay in the northwest corner of the mow was hot, as evidenced by the emission of vapor, and the presence of the characteristic odors of severe self-heating. These conditions were so marked that he felt certain the hay would eventually ignite if left undisturbed, and he concluded that this hay should be removed as soon as fire-fighting facilities could be provided to augment the water-pressure system on the farm.

Near-by fire departments were called and arrived in the late afternoon of the same day. A hose line was laid up through the hatch into the mow, and inadvertently the double doors at each end of the mow were opened shortly before 6 P.M. As these doors were opened fire broke out in the northwest corner of the mow, accompanied by a muffled explosion and a flash of

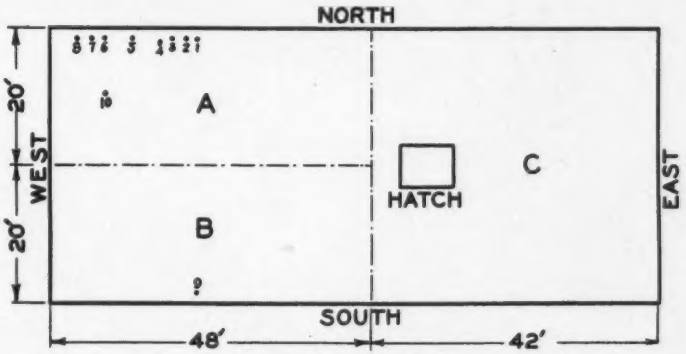


Fig. 2. Plan of mow floor.

flame over the surface of the hay. The fire departments immediately went into action and the fire was brought under control after the roof and upper section of the barn had been destroyed, as shown in Fig. 3.

Observations of Hay in the Mow After the Fire.

This fire was investigated on July 25. Exploration in the interior of the mow could be made only as the hay was removed. Consequently the observations made on July 25 were continued on July 30 and August 3.

Observations on July 25.

No evidence of heating was found in the hay being removed from the eastern end of the barn. There was a 2-ft. layer of chopped oat hay on top of the alfalfa hay in the northwest section of the mow where the fire was said by Mr. Forrest to have broken out. No evidence of heating was observed, however, in this oat hay and we were puzzled as to just where the fire had started.

At a point approximately 8 ft. from the west and 10 ft. from the north we dug down about a foot and found considerable black, damp hay. A pointed 1-in. pipe was driven vertically downward here for a distance of 4 ft. (Greater penetration was not made because the thermocouple protecting tube on the indicating recorder used was only 4 ft. long.) A constant temperature of 72° C. (161.6° F.) was recorded at this location. At another point approximately 12 ft. from the west and 8 ft. from the north another hole was dug 1 ft. down, revealing a dry brown hay. The pipe was driven vertically downward 4 ft. at this location, and a constant temperature of 69.5° C. (157.1° F.) was recorded.

It was evident that satisfactory probings and observations could not be made until the hay in the western end of the barn was being removed. These limited observations showed, however, that somewhere in the northwest area of the mow severe self-heating had occurred below the surface.

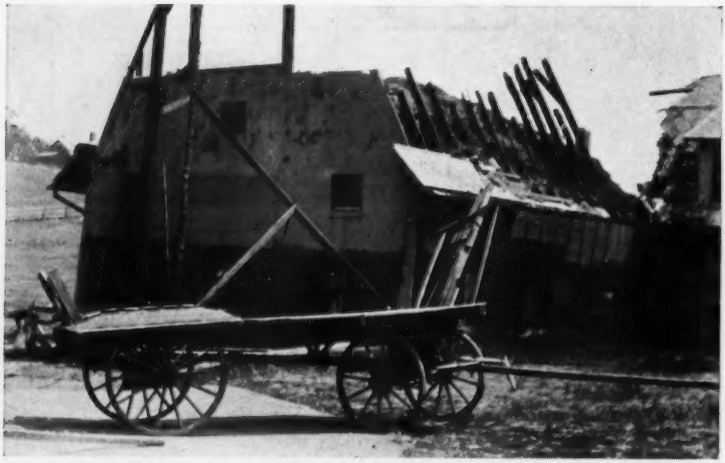


Fig. 3. View of the barn from the southwest, taken after the fire. The fire broke out in the northwest section of the mow, shown at the extreme left.

Observations on July 30.

Removal of a strip of hay a few feet wide was started along the northern wall at the western end of the mow. Here the height of the hay was approximately 2 ft. above the plate, or 8 ft. above the floor. The procedure was to remove consecutive vertical sections from the surface to the floor, to a horizontal depth of about 2 ft.

The first evidence of severe and abnormal self-heating in the hay beneath the surface was noted at a location about 24 ft. from the west. The following hot spots (see Fig. 2) were successively discovered:

No. 1—1½ ft. from the north (around wooden brace), 22 ft. from the west, 5 ft. from the floor.

No. 2—1½ ft. from the north (around wooden brace), 20 ft. from the west, 5 ft. from the floor.

No. 3—1½ ft. from the north (around wooden brace), 18 ft. from the west, 5 ft. from the floor.

No. 4—2½ ft. from the north (near wooden brace), 17 ft. from the west, 4½ ft. from the floor. A small section 6 in. in diameter had burned to ash. The temperature a few inches in was 141° C. (285.8° F.). The black hay around the ash glowed within a few minutes after exposure to the air. (See Fig. 4.)

No. 5—1½ ft. from the north (around wooden brace), 12 ft. from the west, 5½ ft. from the floor. The brace was severely charred and almost burned in two. Apparently the fire started here and spread from the surface of the hay above when air was admitted into the mow through the end doors. The temperature in the black hay near the brace was 107° C. (224.6° F.); the temperature in the dry brown hay 1 ft. south of the black hay was 85° C. (185° F.). The black hay was found to extend downward to about 2 ft. from the floor.

Fig. 4. Hot pocket No. 4, showing hay which had burned to ash. The surrounding hay glowed within a few minutes after exposure to air.

Fig. 5. View of hot pocket No. 10, twenty-one minutes after exposure to the air. Thirty minutes after exposure a hose line was applied.

No. 6—1½ ft. from the north (around wooden brace), 8 ft. from the west, 5½ ft. from the floor.

No. 7—1½ ft. from the north (around wooden brace), 6 ft. from the west, 5½ ft. from the floor.

No. 8—1½ ft. from the north (around wooden brace), 4 ft. from the west, 5½ ft. from the floor.

Heating at hot spots numbers 5, 6, 7, and 8 had been especially severe, as evidenced by the condition of the hay and braces at these locations.

White mold was very heavy in the hay on top of the plate and immediately against the tile wall on the north, indicating an original high moisture content of the hay.

No. 9—1½ ft. from the south (near wooden brace), 22 ft. from the west, 4½ ft. from the floor. Here the hay was black and carbonized, and the brace was badly charred. Evidently the heating at this spot, although severe, had not progressed to the ignition point because of lack of air.

Removal of the strip of hay next to the wall on the north, west, and south was completed, leaving the large mass of hay at the center exposed on four sides.

Observations on August 3.

Removal of hay from the central area revealed the following hot spot:

No. 10—8 ft. from the north, 10 ft. from the west, 3 ft. from the floor. Here the hay was black and damp. Smoking occurred upon exposure to the air. The temperature was 88° C. (190.4° F.). Observation of the condition of the hay at this location was continued by tunneling into the mass with pitchforks. At a location 10 ft. from the

north, 8 ft. from the west, and 3 ft. from the floor, the hay was very black, carbonized, and drier than at the surface. A thermometer inserted horizontally to a depth of 6 in. at this point registered 150° C. (302° F.), its maximum, and was immediately removed to prevent breaking. Shortly after exposure this area (about 18 in. in diameter) began to smoke with increasing intensity, and within 15 minutes glowing and ash formation occurred. (See Fig. 5.) Within 30 minutes after exposure this area was glowing and smoking so intensely that water from a hose line was applied to stop the burning.

Althought the hay at this location was heating severely, it was our opinion that the outbreak of a fire here would have been very unlikely if the mow had been left undisturbed because of the remote probability of the infiltration of outside air to this region.

The striking observation was made that at hot spot No. 10, as well as at all the others, the area of intense heating was highly localized and comparatively small. The appearance of the hay surrounding these hot spots was also interesting. Progressing from the outside edge toward the center of a heating area, the following physical characteristics of the hay were observed: (1) Light brown hay, very dry and having a "dull finish"; (2) dark brown hay, dry and possessing a "glossy finish"; (3) black, damp hay, still retaining its original form, with the inside of the stems brown; (4) black, dry hay, completely carbonized, which when rubbed or compressed was readily pulverized. If a "fire pocket" had formed, there was a small central core of white or gray ash.

The light brown hay had a tobacco-like odor, characteristic of hay which has undergone a heavy "sweat"; the dark brown hay possessed a pungent odor, not particularly offensive; the black, wet hay had a very penetrating, acrid odor, irritating to the nose and the eyes; the carbonized hay was practically devoid of odor.

Most of the hay in the northwest section of the mow was unfit for feeding, owing to deterioration caused by excessive spontaneous heating.

Collection and Analysis of Gas Samples.

The following samples of gas were collected on August 3 in the immediate vicinity of hot spot No. 10, both before its exposure to the air and after exposure, when smoking and glowing of the exposed hay were in progress. The temperature of the hay at this spot was 88° C. (190.4° F.).

"A"—This sample was collected at hot spot No. 10 before exposure by inserting the gas-sampling device to a horizontal depth of 1½ ft. toward the south from the original hay surface and 3 ft. from the floor. Analysis showed: Carbon dioxide, 1.39%; oxygen, 19.33%; combustible gases, none. From this result it appears that the slow combustion taking place with limited supply of air in this locality had been accomplished by a consumption of oxygen very slightly in excess of the carbon dioxide produced.

"B"—This sample was collected at a horizontal distance of 1½ ft. south of hot spot No. 10. Analysis showed: Carbon dioxide, 0.53%; oxygen, 20.72%; combustible gases, none. This result shows the very slight combustion occurring

when access of air was more restricted than at the location represented by sample "A."

"C"—This sample was collected at the exposed surface of hot spot No. 10 while the hay was heating rapidly toward ignition, with the evolution of dense smoke, glowing, and ashing. It represents a mixture of the products of combustion greatly diluted with air. Analysis showed: Carbon dioxide, 1.85%; oxygen, 20.86%; combustible gases, none.

"D"—This sample was collected at a point about 6 in. in from the glowing surface of hot spot No. 10. Analysis showed: Carbon dioxide, 1.46%; oxygen, 20.30%; combustible gases, none. This result shows there was less combustion at this point than at the immediate glowing surface, and that as expected, there was less air accessible for the combustion.

These four samples of gas indicate that carbon monoxide and other combustible gases were not present in the localities where the temperature of the hay did not exceed 88° C. (190.4° F.).

They further show that the combustion occurring beyond 88° C. (190.4° F.) and up to the ignition temperature of the hay, with a free and plentiful supply of air, did not produce as final products any combustible gases. However, at localities where such temperatures were reached in the presence of a limited air supply, considerable quantities of carbon monoxide and other combustible gases may have been produced.

Perhaps such production of carbon monoxide and other combustibles already had occurred at hot spots Nos. 1 to 8 inclusive before opening of the mow doors made available sufficient oxygen for the rapid combustion of these gases and the spread of flame noted.

Conclusions.

This is a clear-cut case of spontaneous ignition of chopped hay. It is evident that a considerable portion of the first cutting, 1934 crop alfalfa hay was either undercured or became wet subsequent to curing, and heated to a marked degree in storage. Most of the undercured or wet hay was apparently stored in the northwest section of the mow. Heating was especially severe in the hay which surrounded the wooden bracing that extended from the floor to the rafters, near the north wall. (See Fig. 6.)

With the formation of hot spots or "pockets" around the diagonal brace, a few feet from the floor, the heat generated had a natural but somewhat restricted outlet upward. This resulted in the formation of a flue around the slanting member of each support in this region. A slight but constant movement of air also occurred from the surface of the mow downward along the north wall to the hot "pockets." Thus the heat generated in the hay at these locations was not dissipated faster than it was produced, and at the same time there occurred the necessary infiltration of air to these "pockets" to carry on the heating until dangerous temperatures were obtained. The accelerated movement of air through the barn, created by opening the double doors at each

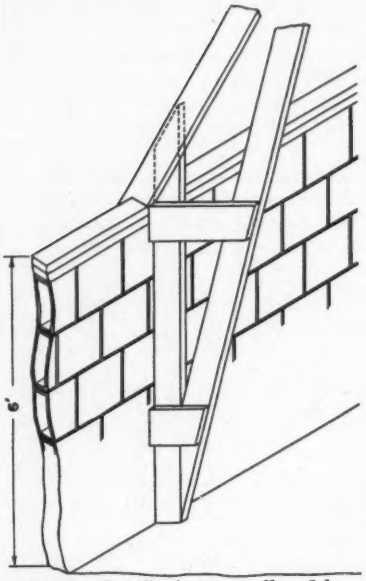


Fig. 6. Detail of mow wall and lower roof truss.

end of the mow, undoubtedly caused the hot areas to burst into flame at the surface of the mow.

From such observations as we have made, or which have been reported to us, it appears that when hot spots or "pockets" have developed in chopped hay in storage they are numerous, quite small, and scattered, but not necessarily at the center of the mow.* In long hay, as these observations indicate, generally only one hot "pocket" is formed, much larger, and located usually at or near the center of the mow.

This fire did not cause greater damage only because adequate fire-fighting facilities were in readiness to combat it. This case emphasizes the importance of knowing the general condition of hay in storage and of providing water and fire-fighting apparatus before removing hay which has reached an advanced stage of self-heating.

*In the Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 17, No. 4, May 1935, Professor H. H. Musselman reports on the spontaneous ignition of chopped hay stacked on the College Farm.

Brooklyn Waterfront Warehouse Fire.

Report by New York Board of Fire Underwriters,
(Member N.F.P.A.).

Fire which defied the efforts of a large number of firemen for nearly three days practically destroyed the New York Dock Company's Store No. 38 in Brooklyn, N. Y., on Saturday, April 20, 1935. This warehouse contained 9260 cases of crude rubber, which gave off dense smoke. The smoke and fumes entered a subway under the East River through ventilating ducts located in a building directly across the street from the fire. Smoke filled the subway to a point in Manhattan approximately two miles from the fire. Several hundred passengers were affected and it was necessary to close the subway for several hours. Loss in the fire exceeded a quarter of a million dollars. Had the warehouse been equipped with automatic sprinklers it is reasonable to assume that the fire would have been extinguished with small loss.

Construction and Occupancy.

The building was one of a row of similar structures five stories high of brick heavy-joisted construction, extending between Furman street and the Brooklyn waterfront. The structure was separated from adjoining storehouses on either side by heavy brick division walls, with a four and a half foot parapet twelve inches thick. The building did not seriously expose any other structure as the side walls were blank and the window and door openings in the front and rear walls were protected by heavy shutters of sheet iron. One of the central rows of shutters was provided with hand holes to permit opening from the outside. The lack of hand holes in the other shutters was a severe hindrance to the firemen and the hand hole on the first floor on the Furman Street front was riveted closed. A stairway and merchandise chute, which were the only vertical openings in the building, were not a factor in the spread of the fire.

The first and second floors of the building each contained 4620 cases of crude rubber. These cases were piled four and five high and averaged 224 pounds per case. The first floor also contained seven hundred rolls of heavy paper used for lining freight cars. The three upper floors were vacant.

Origin and Discovery.

The fire originated on the first floor, approximately fifty feet from the river side. The doors and shutters on the first two floors had been opened the morning prior to the fire for ventilation purposes. A watchman went through the building at 11:20 A.M. Saturday, but found nothing wrong. Five men taking rubber samples had been working in the building until nearly

Smoke from burning rubber in the Brooklyn waterfront fire was drawn through a ventilating inlet for the New York subway system. The inlet, in the direct path of the dense smoke in the right background of this picture, could not be effectively closed and after several hundred passengers had been affected by smoke the subway system was closed for several hours.

Fighting the fire from the river side. Nine million gallons of water at 200 lbs. per sq. in. pressure were furnished by the high pressure fire system, in addition to water pumped from the harbor by fire apparatus, which had an aggregate capacity of over 40,000 gallons per minute. In the absence of a sprinkler system or any effective means of reaching the seat of the fire, the quantity of water had little effect beyond the immediate vicinity of the windows.

noon on Friday, the day before the fire. A watchman closed the doors and shutters on the water side at approximately 11:50 A.M. He was locking up adjacent buildings when his attention was called to smoke coming from cracks of the door of No. 38 storehouse. An alarm to the fire department was sounded through a special building alarm at 12:01 P.M. The watchman, together with his superior who was near by, hurried to the building and unlocked the door. Due to the heavy smoke the door was kept closed until firemen arrived.

How the Fire Was Fought.

The building alarm was followed by five alarms and two master calls, bringing aid from Manhattan, Bronx and Queens in addition to the Brooklyn apparatus. A total of twenty-nine engine companies, including three fire boats, eight ladder companies, three water towers, two rescue companies and eight chief officers, were at the fire. The building is in the high pressure district, with numerous high pressure hydrants on Furman Street. During the height of the fire the pressure on the system was raised to two hundred pounds

and the system delivered over 9,000,000 gallons of water in addition to water pumped by fireboats and pumpers. There are no hydrants on the water side, but suction from the river was readily available for pumping engines in addition to the water pumped by the fireboat. The total pumping capacity of the apparatus responding was over 40,000 gallons per minute.

The fire spread through the building by burning through the heavy floors and finally through the roof. As the fire increased, heavy smoke of a particularly toxic nature was given off and on the first day one hundred and fifty firemen required treatment and thirty were removed to hospitals. The fire was principally fought from the streets with water towers and other heavy stream appliances and hose lines on the roofs of adjacent buildings. Streams were ineffective beyond fifty feet inside the building. Eventually openings were made through the walls from adjoining buildings. Late Monday afternoon about nine thousand pounds of foam powder was used, supplying four streams. The foam was apparently fairly effective in covering the burning mass of rubber, and most of the apparatus was returned to quarters.

Smoke in Subway System.

A tunnel of the I.R.T. subway system between Brooklyn and downtown Manhattan starts at a point beneath and at approximately the center of the burned building, while directly across Furman Street are located the vent shafts and ventilating equipment of the tunnel. There are two shafts, each with metal ducts about four and one half feet square with mechanical draught. Each vent shaft also has openings, about eighteen by eight feet in size, practically entirely open into the subway. The smoke from the fire was blown and drawn down these shafts in such quantities that it completely filled the subway and emerged in large quantities from openings on the Manhattan end. Subway passengers were seriously affected by smoke and fumes and several hundred required treatment. Eventually the tunnel was closed to traffic for several hours, as attempts to close vent openings with tarpaulins failed to make them tight enough to exclude the smoke.

Cause and Loss.

The cause of the fire has not been determined. Aside from the electric lighting equipment there was nothing within the building likely to start a fire and an examination of the electrical equipment showed that it was not responsible. Reports were circulated that the fire was due to spontaneous ignition of crude rubber. As rubber under ordinary storage conditions is not susceptible to spontaneous ignition, and as this rubber had been in storage eighteen months, the theory of spontaneous ignition must be excluded in this case. The fire marshal's office is making an investigation of the cause.

The interior of Building No. 38 was largely burned out; only a small portion of each floor that had been covered by hose streams was not burned. The entire roof was destroyed and the side walls were badly spalled on the

interior. Although a large amount of rubber was burned, considerable salvage is expected. The paper stored in the building, although mostly unburned, was badly water soaked. A considerable portion of downtown Brooklyn was affected by the sticky smoke, which caused numerous smoke losses.

The exact loss has not been determined. The building was insured at $37,500, and the contents at between $300,000 and $400,000. It is estimated that the total loss will be over $250,000.

Consolidated School Fire, Timnath, Col.

Report by Mountain States Inspection Bureau,

(Member N. F. P. A.).

A rural consolidated district school near Timnath, Col., was destroyed by a fire which started while the school was in session on March 21, 1935, and caused a loss of $60,000. Failure of the local school fire alarm bell to effectively notify all occupants of the building of the fire nearly caused a tragedy, as the building was badly charged with smoke when the last class marched out. The value of properly conducted fire drills was demonstrated.

The school was a two-story brick-joisted structure with twenty-seven rooms. Two hundred and ten pupils were attending classes the morning of the fire. Defective temporary lamp wiring beneath the stage of the auditorium and used in connection with plays is blamed for the fire. The fire was discovered in the auditorium on the second floor about eleven in the morning by a pupil, who notified her teacher. The teacher promptly sounded the fire drill signal on the gong in the hall and the main body of students and teachers filed out of the school in fire drill order. One of the study room teachers who was last to leave the second floor noticed on her way to the stairs that the door to the commercial class room was closed. She opened it and found that the commercial teacher and her thirteen typing pupils had not heard the alarm, probably due to the noise of the typewriters. The halls were rapidly filling with smoke, so that it was necessary for these pupils and the two teachers to join hands to make their egress from the building.

The local volunteer fire department responded with a hose reel, and outside assistance was called, but due to the very limited water supply the fire could not be checked.

Three Interesting Grain Elevator Explosions.

By Hylton R. Brown and David J. Price,*
N.F.P.A. Committee on Dust Explosion Hazards.

An Explosion of Kafir Corn Dust.(1)

On November 7, 1934, about 1:15 P.M., a dust explosion in the Perry Burrus elevator at Lubbock, Texas, blew out the sides of three bins, ripped several to the bottom, tore up a section of the slab covering, and ignited the dust in five other bins. Fortunately no one was injured, and due to the fire-resistive type of construction the damage was limited to about $25,000.

When the elevator employees returned to work after lunch at 12:30 P.M., they were ordered to turn the kafir corn in one of the interstice bins. The grain had been drawn from the bin and elevated into the scale hopper. Subsequently the conveyor belt in the gallery over the bins was started to convey the grain back to the bin from which it was drawn. One of the employees was at the south end of this gallery watching the flow of grain on the belt, when there was a flash and terrific explosion at the north end of the gallery. He immediately pulled the motor switch to stop the belt and then climbed down the ladder to the ground floor of the work house. He was so frightened that he did not think about coming down on the employees' elevator.

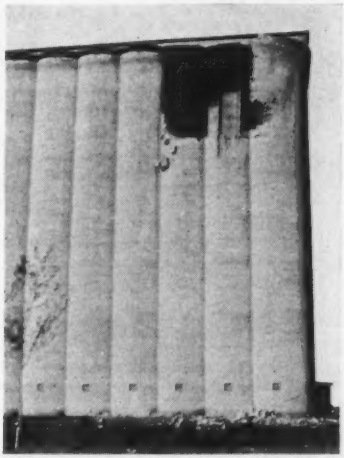
The elevator superintendent was in the office at the time and rushed out when he heard the explosion. Upon investigation he found a large hole in the side of the house extending over three bins. When he reached the top of the elevator he discovered that the force of the explosion had blown the tripper against the motor at the north end of the gallery, and that a manhole cover had ripped the 36-in. conveyor belt for about 75 ft. He also discovered fire in five of the bins. The fire in three of the small bins was extinguished with chemical extinguishers, but it was necessary to call the fire department to extinguish the fire in two of the large bins. It was necessary to pour so much water into these two bins to extinguish the fire that it flowed out of the bottom. It was about 10 P.M. before all fire was extinguished. Further investigation showed some explosion damage to the loading spout at

---

*Dr. David J. Price (member N.F.P.A.), chairman of the N.F.P.A. Committee on Dust Explosion Hazards, is Principal Engineer in Charge of the Chemical Engineering Division, Bureau of Chemistry and Soils, United States Department of Agriculture. Mr. Hylton R. Brown, secretary of the N.F.P.A. Committee on Dust Explosion Hazards, is Engineer in the Chemical Engineering Division, Bureau of Chemistry and Soils, United States Department of Agriculture. The publication of this article in the N.F.P.A. QUARTERLY has been authorized by the Department of Agriculture.

(1) The data on this explosion are based on report of Mutual Fire Prevention Bureau.

the bottom of the bin into which the kafir was running, and also at the small entrance to the tunnel on the north side of the building.



Top of bin walls blown out by kafir corn dust explosion in the Perry Burrus elevator at Lubbock, Texas.

Cause of the Explosion.

Investigators and insurance adjusters feel quite certain that this explosion was caused by static electricity. The drive motor (enclosed type), was unharmed, and the gallery itself was practically undamaged. It is believed that the grain flowing on the belt generated enough static to create a flash between the tripper spout and the manhole collar where there was about a ⅜-in. gap. In support of this belief attention is called to the fact that in this section the static charges have been so heavy that many automobile operators found it necessary to ground their cars by attaching a chain to the frame of the car and allowing it to drag on the ground.

The only other possible cause of this explosion is a metallic spark produced by foreign material in the grain striking the side of the bin. No evidence has been advanced in support of this theory.

Lessons from this Explosion.

This explosion demonstrates very definitely that plants handling kafir corn are subject to practically the same dust explosion hazards as plants handling other kinds of grain.

The value of fire-resistive construction was demonstrated very clearly. With a fire of such intensity in the damaged tanks it would have been difficult to control it if the house had been built of combustible material.

All equipment where static charges may accumulate or be produced should be thoroughly grounded. This usually can be accomplished in a concrete house by connecting equipment to the reinforcing bars. Trippers liable to accumulate a static charge should be definitely grounded through the tripper track to the building framing or reinforcing.

An Explosion in a Wood-frame Metal-clad Elevator.

On November 8, 1934, about 4:50 P.M., a dust explosion occurred at the Chesapeake and Ohio grain elevator in Newport News, Virginia. Fire which followed the explosion completely destroyed the old wooden house and the grain it contained. Four lives were lost, and two employees were treated at the hospital for injuries. The property loss amounted to $770,756.

This house, known as Elevator B, was one of two erected by the Chesapeake and Ohio Railroad to handle its export grain shipments through Newport News. Elevator A was destroyed by fire in 1915. Elevator B had been leased by the railroad company to the Continental Grain Export Company.

Description of Plant.

Elevator B was one of the wood-frame metal-clad houses formerly found in practically all grain centers. Approximately 100 ft. wide, 200 ft. long, and 167 ft. high, with bins 67 ft. deep, the house was capable of storing 840,000 bushels of grain. Bins were covered and had a sliding seal between the bin tops and bin floor.

Extending from the elevator out onto a pier for a distance of about 1200 ft. was a conveyor gallery to provide facilities for handling water shipments. This gallery was cut off by a fire-resistive section to guard against spread of fire from the pier to the elevator, or from the elevator to the pier.

Along one side of the house was located the drier, a brick building about 30 ft. by 35 ft., and 60 ft. high; and the power house, also of brick construction, about 50 ft. by 120 ft. Electricity was used for operating the machinery and lighting the house. Steam was available for heating.

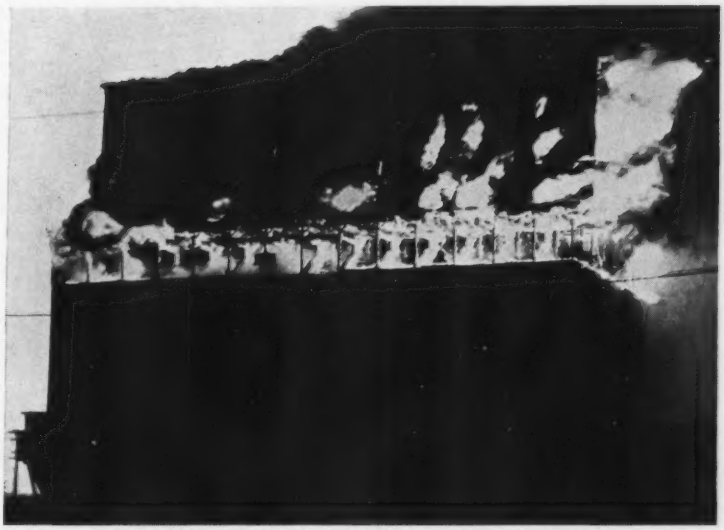
Equipment.

The plant equipment was efficient and, according to all reports, was in good operating condition. No trouble had been experienced during the day's operation. Generally speaking, the same type equipment used in all grain-handling plants was installed in this house, except that it was constructed of wood instead of metal or concrete. Not only were the bins of crib construction (one plank or timber placed on top of another to form the walls), but the elevator legs, garners, hoppers, and spouts were of wood. Rope drives were used to transmit power. Electric wiring was of the open type with vapor-proof lights. Car pullers and power shovels were used for moving and unloading cars on the tracks which ran through the ground or work floor of the house.

Story of the Explosion.

During the day on which the explosion occurred, operations at the elevator consisted almost entirely of turning and transferring grain within the house. A boat containing a cargo of oats from South America was due at the elevator within a few days, and grain was being transferred from the bins in which the oats were to be stored. Some new crop wheat from Ohio stored in the house was found to be heating, and one bin of this grain was being turned at the time the ignition occurred.

Several operations carried on just previous to the explosion included the transferring of grain to prevent it from overheating and the fumigation or treatment of the grain to kill any weevil present. Generally an application of the liquid was made after each 1500 bushels had been run into the bin, and a quantity was ready to be placed on top of the grain as soon as the



Fire on the bin floor which followed a dust explosion in the Chesapeake and Ohio grain elevator at Newport News, Virginia.

last of the lot being turned had run into the bin from the scale hopper. The best information available indicates that there were about 100 bushels in the scale, and grain was still flowing into the bin when the explosion occurred.

Being near quitting time, all operating machinery had been stopped for more than an hour before the explosion occurred. Only the man-lift motor at the east end of the building was running. The watchman with the foreman had used the man-lift to reach the upper floors just a few minutes before the explosion. The foreman got off at the bin floor, and the watchman continued on to the top floor, where he clocked his stations at both ends of the building and descended the stairs to the motor floor. He was walking toward the east end when the explosion occurred, and he reports a sudden upheaval of the floor, with splintered wood flying around just behind him. According to his story everything then became black, but he proceeded toward the east end and reached the window. Outside of this window was an iron ladder, down which he climbed to the ground.

The most direct testimony concerning the start of the explosion and fire was obtained from an employee who was working with the others on the bin floor. He reports that the men were all standing around one of the bins waiting for the last of the grain to flow down from the scale above. Leaving the group for a moment, he walked to the window at the west of the floor, looked out, and then started back. When within about 10 ft. of the group, a flash

All that remained of the wood-frame metal-clad elevator at Newport News, Virginia, after the explosion and fire.

of fire came out of the bin in front of him, and immediately flashed over the bin floor. He turned or fell backward, but succeeded in reaching the stair well and rushed down to the ground level. Evidently the 10 ft. between this man and his companions was the margin between safety and death, because there was no evidence to indicate that any of the other men left the bin floor.

Salvage work was started near the base of the stair well down which the workman escaped with the thought that their bodies might be found there. The search was unsuccessful, and it is assumed that they were caught by the blast at the point where they were working or attempted to reach the west end of the house and were trapped by the flames. It is quite possible that the flash which the employee saw came from either one of two bins or one leg well. Both of the bins were empty, and a flash or blast from either bin or leg well would be between the group of men and the steps down which the workman escaped.

Origin of the Explosion.

In view of the fact that the building and its contents were reduced to a pile of ashes, it has been impossible to find in the ruins any definite evidence indicating either the point of origin or the cause of the ignition. From the statement of the one survivor, and the fact that this was the only point of activity in the house, the most logical conclusion is that the original flash occurred in the dust cloud incident to the flow of grain, and the flames spread from this point across the bin floor and upward through the house.

Possible Causes of the Explosion.

A study of conditions reported to have existed at the time of the explosion and statements of witnesses and employees indicate that the following possible causes should be considered: Overheated grain, friction, electrical sparks, static sparks.

An electrical spark is considered as a possible cause of the ignition, because the men would need light to work in the top of the bin where the fumigant was to be placed. Being late in the day and near the center of the house, a light would be especially necessary. Ordinarily bin lighting was accomplished in this house by flood lighting from above. An automobile headlight with a transformer attached had been arranged on a tripod which could be placed over a bin opening. It was attached to an extension cord leading to the electrical outlet in the center of the house. One of the employees, however, had an impression that this light was not operating or had not been set up.

Knowing that the men were preparing to place the fumigant in the bin as soon as the grain stopped flowing, it is assumed that they were possibly pouring the liquid from one container to another. Such an operation might have created a static spark.

Recommendations.

Should the railroad company or the operating company decide to build a new house at this location, it is recommended that consideration be given to the suggestions and regulations incorporated in the Safety Code for the Prevention of Dust Explosions in Terminal Grain Elevators as prepared by the Dust Explosion Hazards Committee.

The use of a fumigant was definitely associated with this explosion, and it is suggested that studies be made to determine whether fumigants considered safe on the basis of laboratory tests are safe at all times during or after application as practiced in industrial plants.

An Explosion in a New Type Elevator.

Four men lost their lives, and eight others were injured in a dust explosion which occurred at the Cargill grain elevator in Omaha, Nebraska, about 1:20 P.M., November 23, 1934. It is estimated that the damage to building and contents will be about $350,000, at least 85 per cent of which is structural damage. Between six and seven million bushels of grain were stored in the house at the time, and some of this was damaged by the rain and snow which fell after the explosion and before the holes blown in the roof could be covered.

The elevator, located along the Chicago and North Western Railroad tracks west of Omaha, is owned by the Cargill Company of Nebraska and operated by the Cargill Warehouse Company with headquarters in Minneapolis, Minnesota.

Description of Plant.

The elevator, as shown by the accompanying photograph, is radically different from the usual type of grain storage plant. Instead of the battery or rows of cylindrical bins or tanks found in the usual type of elevator, the grain in this house is placed in huge square bins or storage spaces, each one

capable of holding about 1,000,000 bushels of grain.

Through the center of the house and forming the backbone of the structure is a single row of circular concrete tanks of the usual type, and on each side of this central row of tanks are four of the large square storage spaces, approximately 150 ft. square.

Above the central row of tanks is a belt gallery with a conveyor belt and tripper to distribute the grain to any of the storage bins or tanks. Beneath the central row of tanks is a tunnel with a conveyor belt and belt loader used to remove grain from storage. Short cross tunnels also equipped with belts and loaders extend under the tanks at right angles to the central tunnel in the storage section.

The roof consists of corrugated sheet iron attached to cables running from supports above the central row of tanks to anchorages at the ground level beyond the 30-ft. side walls of the storage section. These supporting cables, arranged somewhat like suspension bridge cables, give the house the appearance at a distance of a huge barn with sloping roof.

At the west end of the plant, about 30 ft. from the storage section, is the workhouse, a reinforced concrete structure about 20 ft. by 35 ft. and 158 ft. high. It contains two elevator legs, garners and scales. One leg is used for receiving and shipping. The other leg, known as the transfer leg, is used for handling grain to or from the cleaning house. The house also contains a Humphrey man-lift. At the bin-top level of the storage section a belt gallery connection is provided between the work house and the storage section, and just below ground level a belt tunnel connection is provided between the two sections of the plant. Adjoining the work house on the west are the track shed and car dump.

Directly south of the work house and about 30 ft. from it is the cleaning house, which consists of six circular concrete tanks about 25 ft. in diameter and 92 ft. high, with sufficient space below and above the tanks for the necessary grain-cleaning machinery and an elevator leg.

Operations in Progress.

Operations at the elevator had been proceeding in a normal manner on the day of the explosion. During the morning a number of cars of corn had been loaded, and this work was resumed immediately after the luneh hour. Corn was being drawn from two of the large bins onto the conveyor belt in the tunnel under the center row of tanks. The belt carried the grain westward to the basement of the workhouse, where it was discharged into the boot of the elevator leg. From this point it was elevated to the top of the house, discharged through the garner into the scale, weighed and dropped through the loading spout into cars at the loading dock on the track between the work house and the storage section.

View from the northeast of the Cargill grain elevator in Omaha, Nebraska—an unusual type of grain storage plant.

The cleaning house was in operation, and the elevator leg in this section of the plant was running. Corn was being cleaned, and the grain was running from a bin into the leg, which elevated it to the top of the house. From this point it passed over the cleaner and dropped into another bin.

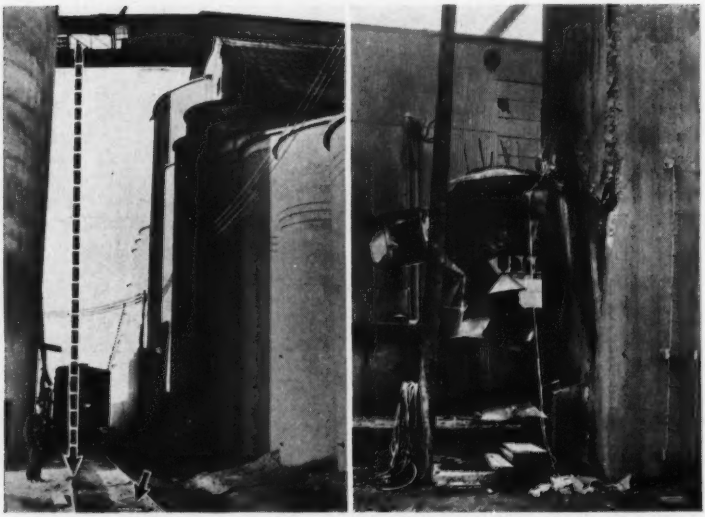
Story of the Explosion.

Apparently without warning of any kind the explosion flashed through the house, approximately 15 minutes after the men had resumed work after the noon hour. As usual, the statements of witnesses varied, but it seems to be generally agreed that the first flash noticed by those outside the building was up through the center of the roof of the storage section. At least two other flashes were noticed in rapid succession, one at the east end of the house and one at the work house. An inspection of the wreckage checks quite closely with the statements of the observers and indicates that the path traveled by the major explosion was upward through the center of the storage section and both east and west from a central point in the tunnel under the storage section. At the west end of the tunnel the flash entered the work house and spread upward. It also traveled southward to the cleaner house through the tunnel and gallery.

The employees in and around the work house and cleaning house were caught in the flames and severely injured. All received burns on the face and arms, and one man died as a result of burns.

From the top of the work house the explosion spread into the gallery leading to the storage section and also through the gallery leading to the cleaning house. The corrugated sheet metal siding on the gallery leading to the storage section was blown off and released the pressure sufficiently to prevent the flames from propagating into the storage section. Unfortunately one workman happened to be sweeping in the gallery at the point where the siding was blown off, and he fell to his death on the railroad track 100 ft. below.

Firemen called to the scene quickly extinguished the flames around a wooden platform supporting a fan near the center of the roof of the storage section, and put out a few small fires elsewhere. Attention was also directed toward possible rescue of the two men known to have been working in the



Cargill grain elevator explosion in Omaha, Nebraska. Left: Position on gallery between work house and storage section from which workman was blown and killed. Right: Wrecked dust collector and damaged south wall of the work house.

tunnel of the storage section. Men attempted to enter the tunnel from both the east and west ends, but found their path blocked by débris and grain from the tanks above. About 15 hours later workmen digging from the east end of the tunnel found one body. The second body was not found until nearly three days after the explosion.

Extent of Damage.

The explosion damage to the structure was not particularly severe, considering the size of the plant or the area covered by the flash. Wherever the explosion was confined, the pressure built up was sufficient to shatter the restraining walls, whether they were reinforced concrete or simply light corrugated metal hooked to steel framework. The greatest pressure was undoubtedly in the tunnel under the storage section. Below ground level and open only at the end where it connected with the work house basement, the tunnel had no weak spots through which the explosion could be vented. The confined explosion built up pressure until it broke through the reinforced concrete bin bottoms which also formed the tunnel roof. Wherever the bin or tank was filled, the weight of the grain provided additional resistance to the pressure below, but the bottoms of bins which were empty or contained only a small amount of grain were blown upward. Equipment in the tunnel was badly wrecked.

The explosion pressure, vented upwards through the empty bins, tore off sections of the roof above the bins and shattered some of the concrete walls in the upper part of the storage section.

The damage in the work house consisted of a bulged and cracked concrete wall on the south side and blown-out corrugated metal walls at the top of the house. The steel elevator leg casing was torn open for nearly the entire height, and the head was blown apart.

Damage in the cleaning house consisted principally of blown-out windows and disturbed equipment. Some fire damage resulted from the ignition of grain in the upper part of the house, and the dust-collecting equipment was partly wrecked.

A comparatively small amount of grain was damaged directly by the explosion or fire. In some cases grain flowed into the tunnel from damaged bins, and this grain became wet or mixed with concrete and débris, which made it unmarketable except for feeding purposes. Grain remaining in the garner in the work house was ignited and continued to burn for some time. The greatest damage was caused by inclement weather shortly after the explosion. Before the holes blown in the roof could be covered, rain began to fall and wet down some of the grain in the storage bins. A few days later snow fell, and the wind blew it into the partly open building.

Point of Origin and Possible Causes.

In tracing the path of the explosion through the house, the evidence found checked quite closely with the statements of employees and witnesses. Machinery and equipment in the tunnel and gallery between the work house and cleaning house were blown or bent toward the cleaning house, indicating very definitely that in this part of the plant the blast had come from the work house.

In the work house there was very definite evidence that the flash had traveled upward. The manner in which the leg casing was torn open and the lifting of steel floor plates checked with the statements of employees on the upper floor that the flame came from below.

In the basement of the work house the condition of equipment indicated that it had been subjected to pressure from the direction of the tunnel under the storage section, and in this tunnel it was found that the conveyor belt and other equipment had been blown toward the west or work house, and from a point at or near the junction of the old and new sections of the house.

In the eastern end of the tunnel the conveyor belt and equipment had been blown about considerably, and it was not possible to check the path of the explosion as definitely as at other points. In most cases, however, the equipment was bent or blown in a direction which would indicate pressure from the west. Except for a small opening, the eastern end of the tunnel was

a dead end, and it is quite likely that the end wall caused a rebound of the pressure wave, and that wreckage originally blown toward the east end was forced back again.

Bin bottoms were very definitely forced upward wherever the bins were empty, indicating that it was through these openings in the bin bottoms and the holes blown in the roof above the bins that the tremendous pressure in the tunnel was released. The explosion flash which shot upward through these openings was the flash noticed by the men working in the bins. There was no evidence to indicate that there was any flash in the upper part of the storage section previous to the blast which shot up from below.

All the evidence indicates that the explosion originated in the tunnel under the storage section at a point near the center of the house where the new and old sections joined.

Several possible sources of ignition were found at or near the point of origin. At this point the conveyor belts under the old and new storage section met, and the grain from one belt was transferred to the other. This change necessitated the use of a type of belt loader which received into a metal hood the grain thrown from the raised end of one belt, and fed the concentrated stream back on to the second belt to continue its travel toward the work house. At this point was the motor which through a drive chain operated the conveyor belt under the new storage section. The necessary starting box, switches, fuse box, interlocking devices, and other electrical equipment were located near the motor. Both the power line and lighting line in conduit ran down to the tunnel from the top of the house through the interstice space between the old and new sections.

At this same point in the tunnel was a fuse box for the lighting line which ran to the eastern end of the tunnel. One of the bodies was found here, and it is believed that this man was sweeping or cleaning at this spot when the explosion occurred. This introduces a human element as a possible cause, because the brush or shovel which he was using could have caught in the belt or in other ways have been thrown around and produced sparks. It seems more reasonable, however, to assume that a spark or flash in the electrical equipment was the source of ignition.

Conclusions and Recommendations.

In the opinion of the investigators a much more severe explosion with greater life and property loss would have occurred if the plant had been of conventional design. The light roof structure was particularly effective in venting (without serious structural damage) the enormous pressure wave which must have been released when the explosion broke through the reinforced concrete of the tunnel. The light corrugated metal siding on the top of the work house vented the explosion and prevented structural damage at that

point, and the top of the storage section released the pressure and prevented the passage of the explosion.

The location of the elevator and its great size make tunnel venting a difficult problem, but it is recommended that in reconstruction full-size openings be provided if possible at the east end of the main tunnel and at the ends of the cross tunnels.

Back Bay Dwelling Fire, Boston.

Fire early in the morning of May 7, 1935, swept through the Boston, Mass., home of John Lavalle, internationally known portrait painter, taking the lives of his mother, two daughters and two maids. Four others were injured. The building was one of a row of four-story, brick-joisted, single family dwellings (see illustration) on Marlborough Street in the Back Bay section of Boston. The owner's invalid mother and the two maids who lost their lives occupied the fourth floor. A cook who escaped with injuries was also an occupant of this floor. The children and their nursemaid had rooms on the third floor.

The fire was discovered and the first alarm sounded by a policeman at 4:55 A.M. When the first apparatus arrived flames were shooting from the

International.

Five lives were lost in an early morning fire in this Back Bay, Boston, dwelling on May 7, 1935. With no provision for automatic fire detection the fire spread to fatal proportions before discovery.

windows. One maid lay dead upon the sidewalk, having jumped from the fourth floor. Mary Lavalle, aged twelve, was fatally burned and injured in jumping from the third floor. Her brother John, aged ten, and her sister Ellen, aged six, escaped with minor injuries. The children's nursemaid, who jumped with them, was seriously burned and injured. The fire department devoted their first efforts toward getting the remaining occupants from the building. They carried a woman overcome by smoke down a ladder from the top floor and as soon as possible brought out the body of Alice Lavalle, aged fourteen, from the third floor and the other three victims from the top floor. A second alarm was sounded, but the fire had such headway when discovered that the interior of the building was practically consumed and the roof burned off.

Cause of Fire.

Several theories were advanced as to the cause of the fire, but due to the headway when discovered the exact cause will probably never be known. It seems fairly certain, however, that the fire originated in the basement kitchen and spread up the open stairway to the roof.

Fire department officials were of the opinion that with the possible exception of the artist's mother all of the victims might have been saved had they remained in their rooms and kept their doors closed. Fire apparatus was nearby and arrived quickly, but unfortunately the victims upon becoming aware of the fire had opened the doors to their rooms, allowing flames to enter, and were probably almost instantly killed. The maid who lost her life by jumping from the fourth floor did so needlessly. There was a balcony fire escape leading to the adjoining house which she failed to use.

Meadowmere, New York, Fire.

Twenty-two cottages in Meadowmere Park, Long Island, New York, were destroyed with a loss reported at $75,000, in a fire on May 19, 1935. Wooden shingle roofs on the majority of the buildings were responsible for the rapid spread of the fire, and inferior public protection handicapped fire fighting, according to the Suburban Division of the New York Fire Insurance Rating Organization (member N.F.P.A.). The fire was fought by volunteer companies from four near-by communities and apparatus from the Borough of Queens, New York City. The fire was on an island, separated from Queens by the creek that may be seen in the foreground of the accompanying picture. The water supply on the island was inadequate for fire fighting, and hose lines from hydrants a quarter of a mile away on the Queens side were laid across the creek by motorboats. Two of these lines may be seen on the beach in the picture. It may also be noted that at low tide it was not practicable

for fire department pumpers to take suction at this point. Obviously the failure to make any adequate provision for water supply for fire fighting and the long delay involved in ferrying hose lines across the creek prevented any effective fire fighting in the early stages of the fire.

International.

The Meadowmere Park, New York City, fire of May 19, 1935. Wooden shingle roofs were responsible for the rapid spread of the fire.

Fires in Which There Was Loss of Life.

Second Quarter, 1935.

Since the publication of the April QUARTERLY, the N.F.P.A. Department of Fire Record has received from various sources 210 reports of fires in which there has been loss of life. A total of 343 lives were lost in these fires. During this period the following four fires were reported in the United States and Canada which caused the loss of more than five lives each.

MARCH 24, 1935, MORTON GROVE, IND. Seven persons died in a fire and resulting panic which occurred in a night club at 2:30 A.M. Sixteen others were injured. The cause of the fire is unknown. The blaze spread very rapidly, due to ignition of combustible draperies and decorations. The first occupants to escape from the building apparently slammed the door shut. As the door opened inward the panic-stricken victims jammed against the door so that it could not be reopened. One of the first men to leave returned for his coat and was among those trapped.

Loss of Life Fires, April-June, 1935.*

This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.

Class of Fire	No. Fires	Men	Women	Children	No Data	Total
Airplane fires	11	21	1	0	0	22
Apartments, hotels, lodgings, tenements, etc.	20	16	7	7	0	30
Automobile fires	8	7	3	3	3	16
Barns and stables	2	2	0	1	0	3
Dwellings—Rural	50	20	20	47	0	87
Dwellings—Urban	60	24	31	40	2	97
Fireworks factory	2	0	3	0	0	3
Forest or brush fires	4	3	1	0	0	4
Garages	2	2	0	0	0	2
Industrial occupancies	7	5	1	0	1	7
Institutions and schools	1	3	1	0	0	4
Mercantiles	7	7	0	0	0	7
Mining property	3	13	0	0	0	13
Oil refinery	1	2	0	0	0	2
Other buildings	6	6	2	5	0	13
Outside of buildings	13	9	1	5	0	15
Prisons	1	3	0	0	0	3
Railroad accidents	2	3	0	0	0	3
Response to alarms	3	4	0	0	0	4
Ships and boats	2	3	0	0	0	3
Tank ships	1	1	0	0	0	1
No data	4	1	0	3	0	4
Total	210	155	71	111	6	343

*This table is made up from those reports received by the Department of Fire Record between March 20, 1935, and June 17, 1935. A few of the fires included herein occurred prior to March 20, but were not reported until subsequent to that date.

Causes of Loss of Life, April-June, 1935.

Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.

Cause	Men	Women	Children	No Data	Total
Airplane fires	21	1	0	0	22
Automobile fires	7	3	3	3	16
Chemicals and explosives:					
Fireworks factory	0	3	0	0	3
Sulphur melting pot	1	0	0	0	1
Children alone in house	0	0	9	0	9
Children and matches	0	0	9	0	9
Clothing ignited:					
Bonfire	4	1	2	0	7
Electric blanket	1	0	0	0	1
Electric heater	0	0	1	0	1
Fireplace	1	0	0	0	1
Match used for light	0	1	0	0	1
Smoking (other than in bed)	2	1	0	0	3
Stove or heater	1	4	3	0	8
Drowned by hose streams	0	0	1	0	1
Entering or re-entering burning building	1	2	0	0	3
Escaping from fire—jumped or fell	4	1	0	0	5
Explosions (miscellaneous):					
Illicit still	1	1	0	0	2
Illuminating gas	1	0	0	0	1
Oil refinery	2	0	0	0	2
Stove (no data)	0	2	1	0	3
Fire fighting—civilians	1	1	0	0	2
Fire fighting—firemen	7	0	0	0	7
Flammable liquids or vapors:					
Bottle of cleaning fluid broken on stove	0	0	1	0	1
Broken range oil container	0	1	0	0	1
Cleaning with gasoline	3	6	2	0	11
Flammable liquids ignited—no data	1	1	0	0	2
Gasoline in garage pit	1	0	0	0	1
Gasoline spilled on clothing ignited	2	0	0	0	2
Gasoline stove exploded	0	0	1	0	1
Gasoline used in oil heater by mistake	0	0	1	0	1
Gasoline used to start fire	0	0	1	0	1
Heating gasoline on stove	1	0	0	0	1
Kerosene casting cleaning machine ignited	0	0	0	1	1
Kerosene used to start fire	8	9	20	0	37
Oil in sewer ignited by match	3	0	0	0	3
Oil stove or lamp	4	4	10	0	18
Gas escaping during fire	1	0	0	0	1
Invalid alone in building	1	0	0	0	1
Mine fires and explosions	13	0	0	0	13
Overcome by smoke—suffocation	5	3	10	2	20
Overexertion—excitement	4	1	0	0	5
Railroad accidents	3	0	0	0	3
Response to alarms	4	0	0	0	4
Ship fires	4	0	0	0	4
Smoking in bed	5	5	0	0	10
Trapped in burning building	33	18	36	0	87
Trapped in forest or brush fire	1	1	0	0	2
No data	3	1	0	0	4
Total	155	71	111	6	343

APRIL 11, 1935, WASHINGTON, D. C. Fire starting shortly before midnight in a small area three-story brick dwelling occupied by three negro families caused a loss of seven lives. The victims, of whom five were children, were all asleep on the third floor, which was not reached by fire. Fire started in the kitchen on the first floor due to an electric iron left in circuit and spread up the stairway to the second floor. Four occupants on the second floor jumped to the ground and one occupant of the third floor escaped to an adjoining building. The remaining seven persons on the top floor were suffocated before firemen arrived.

APRIL 16, 1935, STELLARTON, N. S. Seven miners were killed when an explosion entombed them fifteen hundred feet underground. Rescue workers recovered the bodies thirty-six hours later. Four victims had been crushed by débris from the explosion and three were killed by fire damp which followed.

APRIL 20, 1935, ST. EMILE DE LORETTEVILLE, P. Q. A man, seven of his children, and a maid were burned to death when trapped in a summer cottage by a fire resulting from an explosion of an oil stove. The explosion occurred when one of two maids who were taking care of the children attempted to light the stove. This maid was the only one who escaped. The other occupants were trapped in their sleep.

Typical Loss of Life Fires.

Children and Matches.

L-3029. TAUNTON, MASS., MAY 26, 1935. A six-year-old girl was burned to death when her clothing ignited from a make-believe "birthday cake" in the yard of her home. The "cake" consisted of a flat stone on which the children had placed candles. Shortly after the victim's brother lighted the candles a breeze carried the flames to the girl's dress.

Cleaning with Gasoline.

L-3040. DRUMMONDVILLE, P. Q., APRIL 28, 1935. Two small boys were burned to death in their beds by a fire which started when their father in lighting his pipe ignited clothing which had been just cleaned with gasoline. The clothes were hung in the kitchen to dry and the flash fire which resulted spread so rapidly through the house that the parents were unable to reach the boys.

L-3038. SAN FRANCISCO, CALIF., MAY 4, 1935. Two women, a mother and daughter, were fatally burned as a result of the ignition of gasoline in a pan which the older woman carried past a lighted stove. The daughter was burned when she came to her mother's aid.

L-3026. BELFAST, ME., MAY 30, 1935. A twelve-year-old girl was fatally burned and died in a hospital of burns sustained when her clothing ignited by an explosion of gasoline in her home. The child was assisting her mother when gasoline being used in a washing machine ignited.

Clothing Ignited from Bonfire.

L-3041. CINCINNATI, OHIO, APRIL 24, 1935. A woman was burning rubbish in the yard in the rear of her home. Her clothing ignited and she was fatally burned.

L-3032. ST. GENEVIEVE DE PIERREFONDS, P. Q., MAY 25, 1935. A six-year-old girl was fatally burned when she fell into a bonfire which her brothers and sisters had built in the yard of her home. The child's mother wrapped the girl in a blanket and extinguished the flames, but the victim died in a hospital a few hours later.

Clothing Ignited from Stove or Heater.

H-39575. MONTREAL, P. Q., MAY 14, 1935. A seven-year-old girl was fatally burned and died four days later of burns received when her ballet costume ignited from an electric heater on the stage of a theatre where she and other little girls were participating in a dance recital. Screaming, she ran through a line of young dancers and the flames spread to the costumes of three other children, who were also badly burned.

Flammable Liquids Ignited.

H-39576. ST. LOUIS, MO., APRIL 26, 1935. Three workmen were fatally burned and seven others were painfully injured by a flash fire and explosion in a sewer in which they were working. The fire occurred when a workman dropped a lighted match, which ignited vapor from a flammable liquid which had been discharged into the sewer. Six of the men, unable to reach the surface, remained in the sewer until carried out by firemen with gas masks. Several victims had fallen from the platform on which they were working into the water, where the oily material was burning on the surface.

L-3039. MANCHESTER, N. H., MAY 1, 1935. A woman was fatally burned when fuel from a broken glass range oil container ignited, setting fire to her clothes. The victim was placing the container in the stove when it fell from her hands and broke on the stove. The oil ignited from the stove and the woman was burned on the face and head and died in a hospital to which she was taken by firemen.

L-3031. MONTREAL, P. Q., MAY 25, 1935. The operator of a merry-go-round was fatally burned when gasoline, which he had spilled on his hands and clothing, ignited as he struck a match. The man spilled the gasoline while putting twenty gallons of fuel into the tank of the merry-go-round motor.

Kerosene Used to Start Fire.

L-3051. FARNHAM, P. Q., MARCH 17, 1935. A woman died as a result of severe burns received when she used kerosene to start a fire in her stove. The woman poured kerosene into the stove and a flash occurred when she struck a match. She ran outside, calling for help, but two neighbors who were near by were unable to approach, due to the flames from her clothing. Finally a man beat out the fire and the victim was taken to a hospital, where she died.

L-3048. ALBANY, WIS., MARCH 22, 1935. Kerosene poured on the embers in a kitchen stove caused a rapid spreading of fire, which trapped three children in their farm home. The fire started when one boy started the stove fire while the rest of the family was asleep. The parents saved four children, one of whom was badly burned, but two boys and a girl were trapped.

L-3045. ONALASKA, WIS., APRIL 8, 1935. Two children were burned to death and their parents and two other children were severely burned in a fire which started when the father poured kerosene on a coal fire.

L-3043. SOUTH DAYTON, N. Y., APRIL 14, 1935. Two women and two children were fatally burned when the children's mother threw kerosene into a stove to speed up the wood fire. The room was immediately filled with flames and the victims' clothing ignited. The four died within a few hours after being taken to a hospital.

Match Used for Light.

L-3050. EVANSTON, ILL., MARCH 17, 1935. A woman was fatally burned when her clothing ignited from a match she was using for a light while rummaging in her attic. Her husband beat out the flames. She died three hours later in a hospital.

Re-entering Burning Building.

L-3042. MEAFORD, ONT., APRIL 14, 1935. One of five persons who escaped from a burning farmhouse was burned to death when she returned to save some papers which she valued.

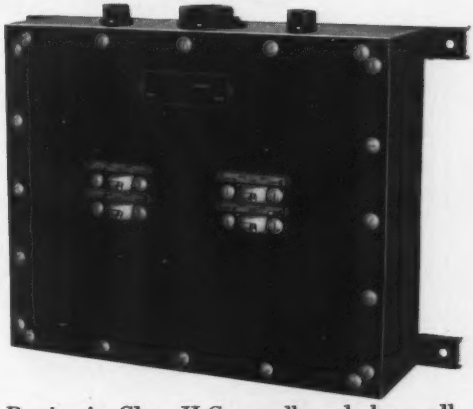
Smoking.

S-69850. EDGEWATER, N. J., MARCH 16, 1935. An employee engaged in cleaning a factory spray booth was fatally burned by a fire which started in the booth, due to a cigarette he was smoking as he worked.

for Grain Elevators and Similar Dusty Locations

BENJAMIN Dust-Tight

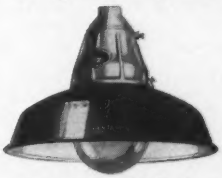
Panelboards and Lighting Fixtures



Listed by Underwriters' Laboratories for Class II-G Hazardous Locations.

Dust and moisture-proof. Specially designed to meet the rigid requirements for lighting equipments in grain elevators and similar locations in which combustible dust is present in the atmosphere.

Benjamin Class II-G panelboards have all the electrical and mechanical features of Benjamin NOFUZE panelboards, with the added features of being dust and moisture-proof. Branch and main circuit-breakers are operated by external means, removing the possibility of breaking an arc in dust laden atmosphere.



Type II-G Dust-Tight Fixture

Benjamin "Type II-G" lighting fixtures are dust-tight and moisture-proof, and fitted with screw-thread enclosing globe. Available without reflectors, or with Dome, Bowl, Flat Cone, and Symmetrical Angle reflectors to meet specific lighting requirements.

Write for full information on Benjamin Panelboards and Lighting Fixtures which meet Underwriters' Laboratories requirements for installation in hazardous locations.

BENJAMIN ELECTRIC MFG. CO.

General Offices and Factory

DES PLAINES, ILLINOIS

Divisional Sales Offices

NEW YORK :: CHICAGO :: SAN FRANCISCO

FOR ALL TYPES OF

CLINICAL PHOTOGRAPHY

•

ALL Eastman films suggested for clinical photography . . . *Process, Portrait Panchromatic, Par Speed* and *Super Speed Portrait, X-ray, Dental X-ray, Cardiographic* . . . are available on cellulose acetate base. The last three named are coated on this "safety" base exclusively. And all of these materials . . . which present even less hazard than newsprint paper . . . are at the disposal of the medical and dental professions without added cost. Eastman Kodak Company, Rochester, N. Y.

EASTMAN

SAFETY FILMS

THE TIDE OF PLEASURE
NEVER EBBS
AT

Chalfonte-Haddon Hall

These friendly hotels are located on the beach, where you may step right onto the soft white sand. Our cabanas are pitched there, too, inviting you to their colorful colony after a dip in the deep. Another favorite spot with guests (especially around noontime) is the Surf Club Grill. Here you may lunch informally without the bother of changing from your swimming togs.

Indoors, too, unique hospitalities unite to make your sojourn restful and amusing. Here concerts, dances, and varied diversions yield to that yen for activity, while the quiet lounges, health baths, and your own cheerful room make relaxation sublime. We also promise you tempting meals. Moderate rates, on either the American or European Plan. Special weekly rates.

LEEDS AND LIPPINCOTT COMPANY
ATLANTIC CITY

NOFUZE "DE-ION" BREAKERS

make wiring protection

PERMANENT

Above—*Cutaway view of a Westinghouse "De-ion" Circuit Breaker similar to those used in the Panelboard shown below.*

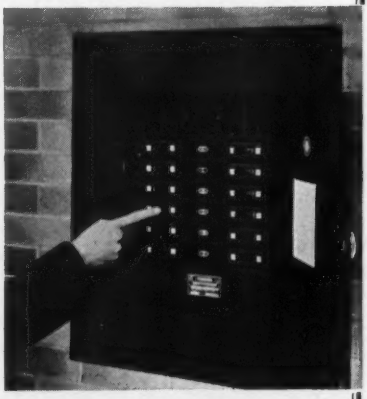
THERE is nothing to burn out or replace when electrical circuits are protected by Westinghouse Nofuze devices. Their "De-ion" Circuit Breakers, which replace fuses, provide *permanent, certain* protection that is tamper-proof. They completely eliminate the hazards of blocking blown fuses with pennies, wires and other makeshift electrical conductors.

Protection is *permanent* because the "De-ion" Breakers are accurately calibrated at the factory, and *sealed* in a molded housing.

Protection is *certain* because the breaker trips free from its handle when interrupting the circuit under harmful overload conditions. No one can hold it closed, or block its opening action.

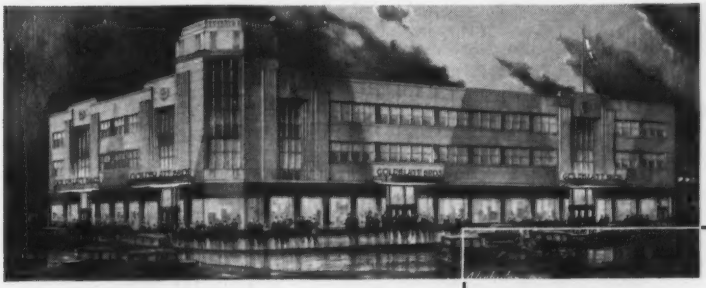
"De-ion" breakers are used on Westinghouse Nofuze Load Centers and Panelboards for homes and buildings, and on Nofuze Circuit Breakers for industrial applications. *They are approved by the Underwriters' Laboratories.*

Below—*A Westinghouse Nofuze Panelboard. When a short circuit or heavy overload occurs, the breaker protecting that circuit automatically opens. After the overload is removed, and only then, service can be restored instantly by a mere flip of the breaker handle.*



Westinghouse

T 85093



Goldblatt Bros.
Chicago, Ill.
Alfred S. Alshuler, Inc.
Architect

Three-story and basement building, 212 x 136 ft., now being erected at 91st St. and Commercial Ave.; completed standard Viking Automatic Sprinkler System with concealed piping on first floor; water supplies — gravity tank and fire pump taking suction from city water main.

Meeting
MODERN REQUIREMENTS

• Viking Sprinkler Systems embody every engineering refinement known to this fire prevention industry. To meet the requirements of every type of risk Viking has developed three separate types of systems: the Viking Dry Pipe and the Viking Wet Pipe Systems for ordinary risks, the Viking Pre-Action and Deluge System for the extra hazardous risks. Viking engineers can therefore recommend a system which affords the greatest degree of protection and earns the lowest insurance rates because it is designed to meet the exact requirements of the risk. This, together with the Viking deferred payment plan, enables Viking to meet every requirement of modern industry and business.

This booklet on extra hazardous risks belongs in your reference library . . . your request brings you a complimentary copy.

VIKING
AUTOMATIC SPRINKLER SYSTEMS

VIKING COMPANIES:

Atlanta, Ga.-Charlotte, N. C.—Crawford & Slaten Co.
Boston, Mass.—Viking Automatic Sprinkler Co.
Buffalo-Syracuse, N. Y.—Viking Automatic Sprinklers, Inc.
Chicago, Ill.—Viking Automatic Sprinkler Co.
Cincinnati-Cleveland, Ohio—Viking Sprinkler Co.
Dallas-Houston, Texas—Texas Automatic Sprinkler Co.
Detroit, Mich.—Viking Sprinkler Co.
Grand Rapids, Mich.—Viking Automatic Sprinkler Co.
Huntington, W. Va.—C. W. Hutchinson, Inc.
Indianapolis, Indiana—Indiana Automatic Sprinkler Co.
Kansas City-St. Louis, Mo.—Walton-Viking Co.
Los Angeles-San Francisco, Cal.—Viking Automatic Sprinkler Co.
Minneapolis, Minn.—Viking Automatic Sprinkler Co.
New York, N. Y.—Viking Automatic Sprinklers, Inc.
Philadelphia, Pa.—Viking Sprinkler Co. of Pa.
Seattle, Wash.-Portland, Ore.—Viking Automatic Sprinkler Co.
Toronto, Ontario—Viking Automatic Sprinklers, Ltd.

THE VIKING CORPORATION
HASTINGS, MICHIGAN

GAMEWELL *Master* Fire Alarm Box

Offers Three Valuable Protective Features to Insured Risks

Master Fire Alarm Box

Every fire insurance official should familiarize himself with the *direct-to-the-fire-department* protection which the Gamewell *Master* Fire Alarm Box provides for insured risks. This *Master* Box offers the three following valuable protective features, either singly or in combination:

1. *Sprinkler Supervisory Service*

Both wet and dry pipe sprinkler systems can be connected reliably and economically to a *Master* Fire Alarm Box so that the opening of a sprinkler head will send an alarm *directly* to the municipal fire department—all within a few seconds.

2. *Automatic Fire Alarm Service*

A *Master* Box connected to a Gamewell Automatic Fire Alarm System enables the insured risk to get the most out of automatic fire detection, by transmitting the alarm instantaneously and automatically, *straight* to the municipal fire department—no chance for delay or confusion as might result from verbal alarm transmission.

3. *Manual Fire Alarm Service*

The same *Master* Box can be used to provide an insured property with direct-to-the-fire-department manual alarm service by connecting it to a Gamewell Remote Control System installed inside the property. This hook-up makes it possible to send an alarm manually to the municipal fire department without leaving the building.

Would you like to receive descriptive literature?

THE GAMEWELL COMPANY

NEWTON, MASSACHUSETTS

PAY MORE ATTENTION TO SPRINKLER ALARMS

The Sprinkler Alarm is the step-child of the sprinkler industry. Few give it the attention it deserves. Yet the difference between an instant alarm (Rockwood Sprinklarm) and a slow alarm (the conventional alarm) may cost an owner or insurance company $1,000 or more.

Rockwood has specialized in improving sprinkler alarms. The Rockwood Sprinklarm is the fastest local alarm. The Gamewell Sprinkler Watchman—connected to a Rockwood Sprinklarm is the swiftest method of calling the municipal fire department. Specify Rockwood and get the best sprinkler alarm.

ROCKWOOD SPRINKLER COMPANY
Worcester, Mass.

WORCESTER FIRE EXTINGUISHER CO., LTD.
Canadian Company

National Fire Protection Association

INTERNATIONAL

Executive Office: 60 Batterymarch St., Boston, Mass.

The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the coöperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes over a hundred national and regional societies and associations and more than three thousand individuals, corporations, and organizations.

The QUARTERLY is one of a large number of publications issued by the Association and sent to the members as published. These include the monthly *News Letter*, standard regulations on fire prevention and fire protection, special reports and bulletins, the Year Book, and the Proceedings of the annual meetings.

Membership in the National Fire Protection Association is open to any Society, Corporation, Firm or Individual interested in the protection of life or property against loss by fire. All the valuable engineering and popular literature issued by the Association is sent, as issued, to every member. The Association is the clearing house for all the authoritative information on Fire Protection and Prevention, and members are privileged to submit to it their individual problems for solution. The Association is always glad to send samples of its publications to prospective members upon request.

A·D·T PROTECTION

INSURES PROMPT AND ACCURATE ALARMS

A. D. T. Central Station Protection Services place local fire protective measures under the constant supervision of an outside agency, in continuous direct-wire contact with the fire department. A. D. T. Protection eliminates the greatest fire hazards of all—belated discovery, and delayed and inaccurate alarms.

A. D. T. FIRE PROTECTION SERVICES

Sprinkler Supervisory and Waterflow Alarm Service: Makes your sprinkler system function as an automatic fire alarm . . . automatically summons fire department in case of waterflow. Electrically detects and reports conditions that impair the normal functioning of the system.

"Aero" Automatic Fire Alarm: Automatically detects fire when it starts . . . summons fire department direct to the scene.

Watchman Supervisory Service: Any deviation from watchman's routine instantly and automatically reported to A. D. T. Central Station. Also provides manual fire alarm boxes to summon fire department direct to premises.

Descriptive literature sent on request.

Controlled Companies of
AMERICAN DISTRICT TELEGRAPH COMPANY
155 SIXTH AVENUE · · NEW YORK, N. Y.

A.D.T. SYSTEM

A NATION-WIDE PROTECTION SERVICE
AGAINST FIRE, BURGLARY AND HOLDUP

A·D·T

ANNOUNCING —

(Patented)

The GRINNELL *DURASPEED* CONVECTOR TYPE SPRINKLER

"There is more to this than meets the eye," remarked a man of science, as he studied Grinnell's latest product. What led to this conclusion?

The HEAT COLLECTOR—new in sprinklers, increasing speed of opening when a fire occurs by gathering heat of convection and conducting it to the soldered joint.

The HEMISPHERICAL SOLDERED JOINT—of large area, but exposing a minimum of solder edge to corrosion or loading, and that edge protected by inert wax.

The TAPERED NOZZLE—mirror smooth, less likely to clog, and discharging a solid jet, free from turmoil and eddy.

The STREAMLINE DEFLECTOR—distributing the water it receives with small loss of velocity head.

The SPRING HOOK—burnished to resist corrosion fatigue, and exerting a strong, elastic opening force.

Largely because of these new features of design, executed with the precision and finish characteristic of all Grinnell products, the DuraSpeed sprinkler excels in DURABILITY, SPEED and DISTRIBUTION.

Approved by Underwriters' Laboratories and Factory Mutual Laboratories.

GRINNELL COMPANY
INC.

EXECUTIVE OFFICES

PROVIDENCE RHODE ISLAND

Offices in all Principal Cities of the United States and Canada.